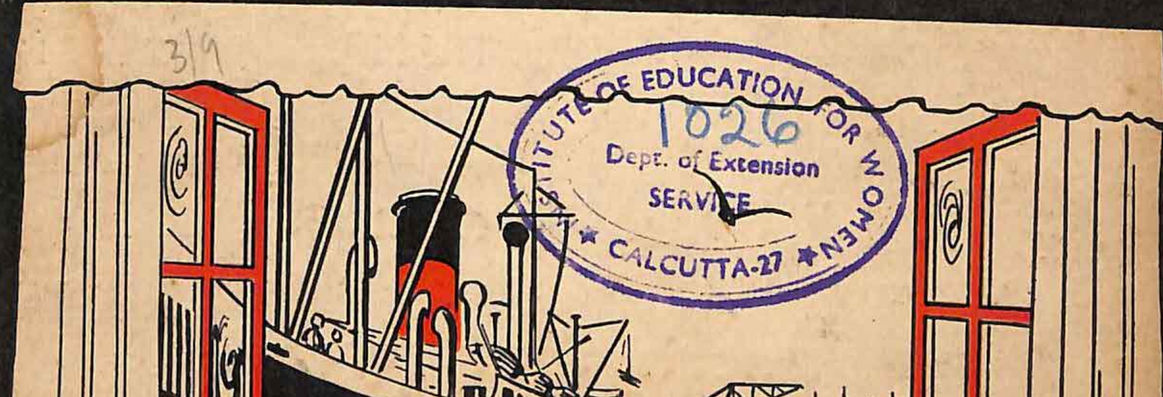
MEN AT WORK

SHIPS



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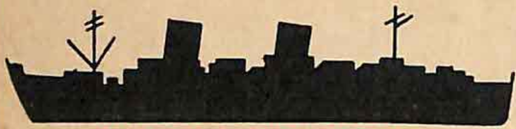
LONGMANS

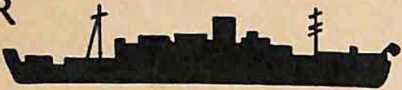
MERCANTILE MARINE

PASSENGER LINER



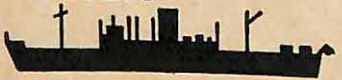
QUEEN ELIZABETH
83,673 TONS

CARGO & PASSENGER LINER



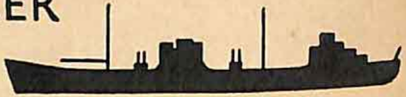
CORINTHIC
15,700 TONS

CARGO LINER



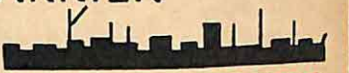
CITY OF LONDON
8,420 TONS

TANKER



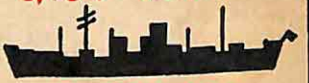
REGENT TIGER
15,000 TONS

FRUIT CARRIER



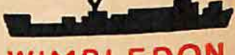
DUNSTER GRANGE
9,494 TONS

TRAMP



GENERTON
4,797 TONS

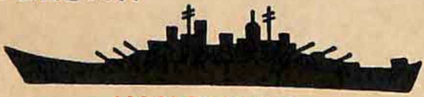
COLLIER



WIMBLEDON
1,598 TONS

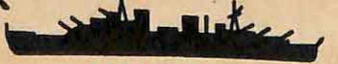
ROYAL NAVY

BATTLESHIP



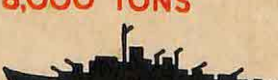
VANGUARD
44,500 TONS

CRUISER



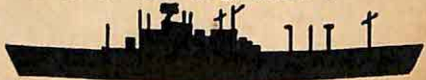
SUPERB
8,000 TONS

FRIGATE



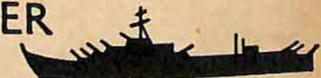
RELENTLESS
1,705 TONS

AIRCRAFT CARRIER



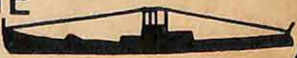
EAGLE
36,800 TONS

DESTROYER



BATTLEAXE
1,980 TONS

SUBMARINE



AENEAS
1,120 TONS

MEN AT WORK

GENERAL EDITOR: T. Herdman, M.Sc.

/c

SHIPS

by

HARRY ROBINSON, B.A., M.Ed.

Illustrated by
V. J. BERTOGLIO
and H. A. BENNETT

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ACKNOWLEDGMENTS

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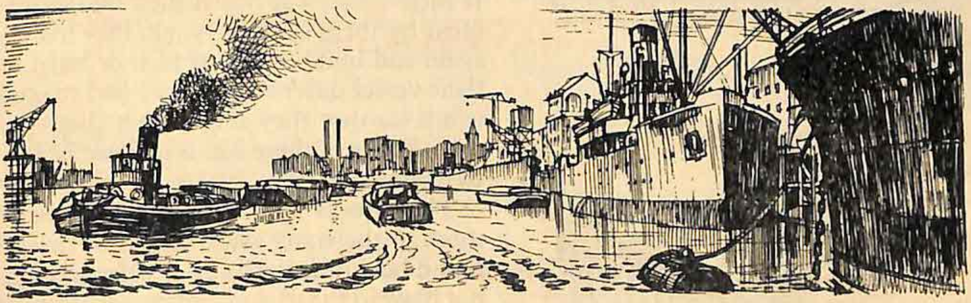


EXPLORING THE OCEANS

It is not easy for us to-day to picture a time when the people of Britain were shut in by the seas around the islands, like prisoners within the walls of a gaol. Yet there was such a time, and that not many centuries ago. Five hundred years ago men could not pass freely from Europe to America or Australia, and even such short sea trips as those from Britain to France or Ireland were regarded as dangerous journeys. The peoples who lived by the shores of the Atlantic Ocean and watched the sun go down beneath its wide waters, told tales of magic islands far away to the west, peopled with strange folk and stranger animals. They never dreamed that a time would come when great vessels such as the *Queen Elizabeth* would safely carry two thousand passengers at a time across those stormy seas. To-day, ships run almost as regularly as railway trains over all but the frozen seas around the poles.

How that became possible is the main story this book will tell. Three great and difficult lessons had first to be learned. These were (*a*) how to build ships; (*b*) how to sail them; (*c*) how to deal with the winds and the waves. Step by step each was learned. Having discovered how to fashion a simple vessel that would float, its builders had next to find some way of driving it along and directing its course. If their vessel was overturned by the waves or filled by them so that it sank, they had to start again and build on a new plan or learn to steer their vessel differently. They had to study the winds so that they might plan their journeys to make use of these winds and not be hindered by them.

The Greeks and Romans drove their ships through the water with long rows of oars and found how to use sails even when the wind did not blow in the direction they wished to follow. The Vikings, facing stormier seas, learned to build ships of a different kind that rode over the waves instead of being driven through

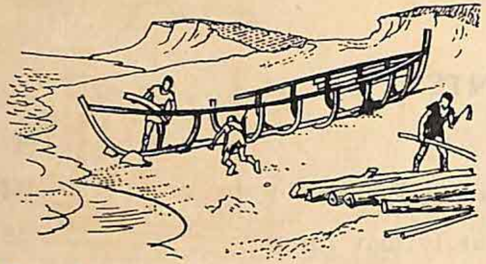


Fig. 1. Early shipbuilders.

Fig. 2. The first lesson in seamanship.

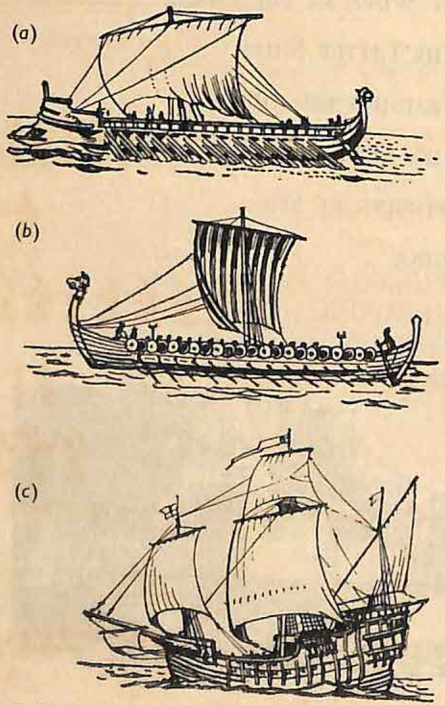


Fig. 3. FROM GALLEY TO WARSHIP:
(a) Greek—350 B.C.; (b) Viking—A.D. 800;
(c) Tudor—A.D. 1500.

them. In their shell-like boats there was room for more food and water and so they could go on longer voyages. They crossed from Norway to Iceland, from Iceland to Greenland, and from Greenland to the shores of North America, centuries before Columbus reached the West Indies from Spain. By the time of Columbus the hull or shell of the ship had been roofed over to keep out the waves and it was driven along by many sails mounted from more than one mast. The bigger ships of his time could stay at sea for several weeks. Their captains had learned to use the compass, as well as the sun and stars to guide them on their way to distant lands. They made charts or maps of the oceans and marked on them the directions in which the winds blew most regularly.

So, step by step, man conquered his old fear of the oceans. The shapes of the hulls were improved to make the ships safer and speedier. Masts and sails were changed to make better use of the power of the wind. New and better instruments and more knowledge of winds and currents enabled the captains to plan quicker and more profitable voyages. In time, iron replaced wood for shipbuilding, and then steel replaced iron. Steam engines with paddle wheels and then screws made sails unnecessary.

At any hour of the day or night there are now thousands of men afloat. Some of them are fishing in the cold northern seas. Many more in cargo boats are carrying great loads of wheat or beef, fuel or timber, across the oceans, and great liners carry thousands of passengers from port to port. Harbours have been made and ports built to help the ships in their work. Many more thousands of men are employed in shipyards building new craft or repairing old ones, and yet others are busy, in and about the docks, loading and unloading the cargoes the ships carry and the supplies they need for their journeys. Sea transport is now one of the great industries.

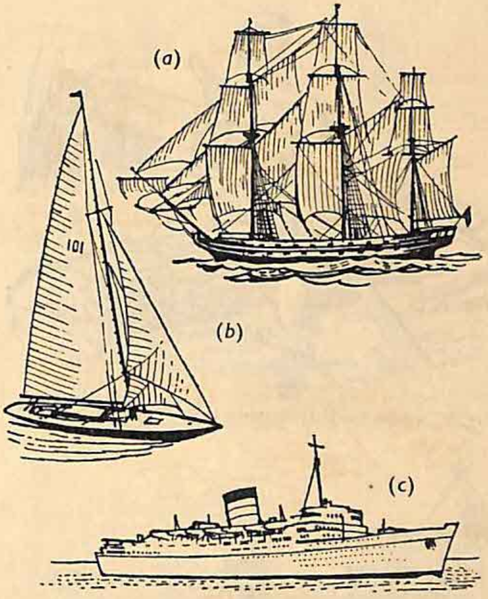


Fig. 4. (*a*) Frigate—1750; (*b*) Racing Yacht—1920; (*c*) R.M.S. *Caronia*—1948.

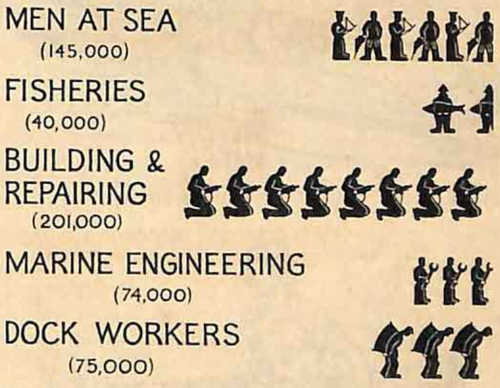


Fig. 5. Workers in the British shipping industry.

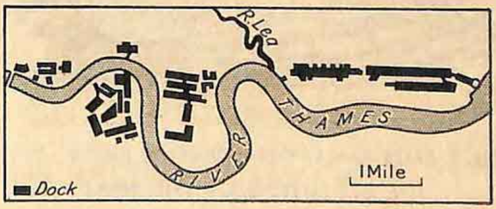


Fig. 6. London's main dock system—all have been cut in the soft rock of the marshy river banks.

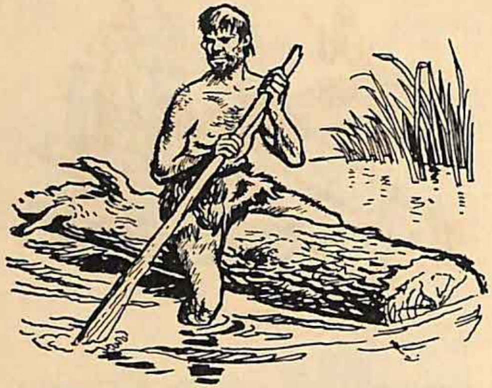


Fig. 7. Stage 1—the floating log.

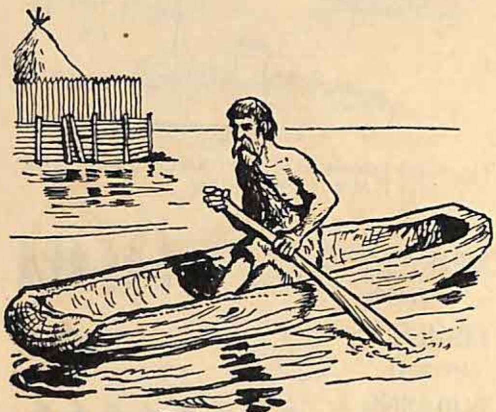


Fig. 8. Stage 2—the hollowed log and paddle.

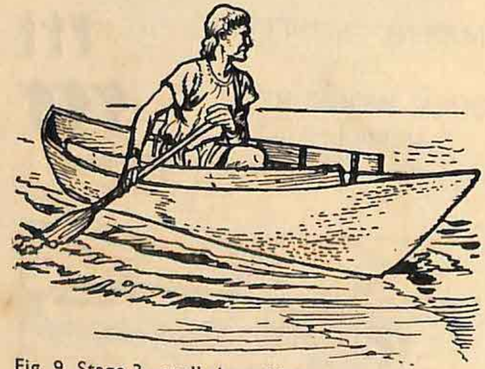


Fig. 9. Stage 3—well-shaped boat and paddle.

THE EVOLUTION OF THE BOAT

THE EARLY BOAT BUILDERS

WE do not know who first had the idea of setting things afloat on a piece of wood. It may have been a boy playing on the banks of a river. Perhaps it was a man who had watched animals clinging to the branches of a tree swept along on a flooded stream. Someone, braver than his fellows, first sat astride a log and found that he could both drive it along and steer it by paddling with his hands and feet. A later inventor found that a group of logs formed into a raft was steadier than a single log and could carry his family and his goods. Yet another found that if he hollowed out a big log he could sit in it and keep himself and his possessions dry. Flat pieces of wood were then used for paddles. Men living in forested lands learned to make such *dug-out* canoes long ago. They are still used on some rivers in Africa, South America and Asia.

In rough water the dug-out easily filled with water. When men had tools good enough to cut out planks, the next step in building was made. Uprights were fitted inside the dug-out and long planks fastened to them to raise the sides and so give protection against swamping. To prevent the dug-out "turning turtle" in rough water the peoples of the Pacific Ocean fastened a piece of wood, often just a branch, to one side of the craft by means of stays. Such a float is called an *outrigger*.

In lands where there were no suitable trees, other materials were sometimes used. The baby Moses was put in a basket woven of reeds from the river bank. The Egyptians had first made banana-shaped boats by tying together bundles of tall reeds. These primitive craft were later improved by weaving the reeds into basketwork and covering this with clay or pitch to keep out the water. Boats of this kind are still used on the Tigris and Euphrates. The *coracle* of the Ancient Britons was of basketwork covered with skins.

Both the coracle and the dug-out had two bad faults. The round shape of the former and the blunt end of the latter prevented them from being driven easily through the water—they pushed the water aside instead of cutting through it. The birch-bark *canoe* of the American Indian was a great improvement on the earlier boats. Like the coracle it had a strong frame and a thin skin. This skin was made of sheets of bark stripped from the birch trees. These could be easily bent into curved shapes to make a boat which was wide and roomy in the middle but pointed at the ends. It was very light and did not sink deeply in the water when loaded. Because it skimmed over the surface and its sharp ends cut through the water, it was both speedy and easy to steer. Because of its lightness, it could be carried around rapids or from one stream to another.

The Eskimo, living on the Arctic shores of Canada, is also a skilful canoe builder. His *kayak* is made by stretching a cover of stitched sealskins over a light framework made from driftwood collected on the beach. The whole boat is enclosed except for a hole in the top in which he sits. When the cover has been laced around his waist no water can enter the boat, even if it is overturned. If it is capsized by a wave or by one of the animals he hunts he can quickly right the kayak by a stroke or two of his paddle.

All these early boats were of little use for anything but to carry a single paddler. Gradually their builders improved these first patterns. Dugouts were made longer to carry more paddlers and a passenger or two. By widening only the middle portion of a canoe, room was made for more goods without lessening its speed very much. It was also found dangerous to deepen the boat without also widening it and long oars were found to be better than short paddles for heavy loads.

All modern boats and ships are built after the canoe pattern. They have a stout framework of steel girders and an outer skin of steel plates. Great care is taken in planning the shape of these ships so that they are as roomy as possible and yet cut easily through the water. They are merely larger and stronger kinds of canoe.

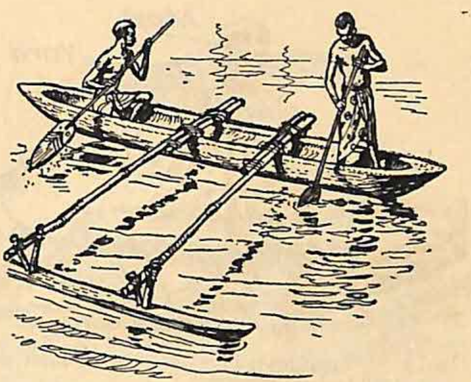


Fig. 10. Dug-out canoe with outrigger. How does the outrigger help to prevent overturning?

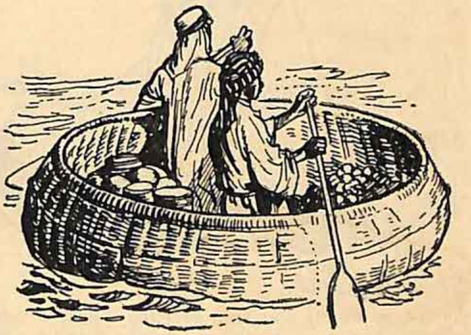


Fig. 11. Guffa on the Euphrates river. How does it differ from the ancient British coracle?

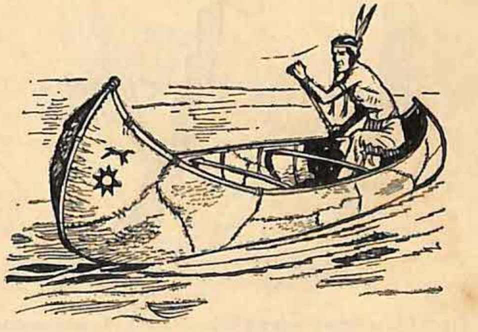


Fig. 12. Indian birch-bark canoe. In what ways is it better than the other boats on these two pages? Why is it so light?

FROM BOAT TO STEAMSHIP

PROBABLY the first sea-going ships were those built on the shores of the Mediterranean Sea. They were little more than big river boats driven along by rows of oars, often pulled by slaves. Soon, however, a short mast was fitted in the middle of the ship and a long spar or yard fastened to it from which a sail could be hung. With a following wind the ship was carried along, although when the wind blew from any other direction oars had still to be used. These simple *galleys* were used for hundreds of years.

Much finer ships were built to sail the stormier northern seas. These too were just large boats driven usually by oars but with the help of a square sail when the wind blew in the right direction. The timber of the northern forests was very suitable for boat building, since it could be cut into thin planks bent to fit the framework. Thus the Vikings made beautifully shaped vessels with high *prows* and *sterns* to keep out the storm waves. The Viking ships were built around one long piece of timber called the *keel*. From it was built a framework like the ribs of a skeleton. The planks, forming the skin of the boat, were fastened to this with wooden pegs. Each plank overlapped the edge of the one below to make the boat watertight. This was called *clinker building*. Most rowing boats are still built in this way. The fir and spruce trees of the north provided straight, tall, flexible masts and yards. The vessels were steered by a large oar or steerboard fastened to the right-hand side of the stern, hence our word *starboard*.

During the Middle Ages "castles" were built in the bows and sterns of the ships and were manned by soldiers in earlier naval battles. When the ships began to make longer voyages the castles provided sleeping places for the crew. The crew's quarters are still called the *forecastle*. Other important changes in shipbuilding were the roofing in of most of the hull to form a deck and the replacing of the steering

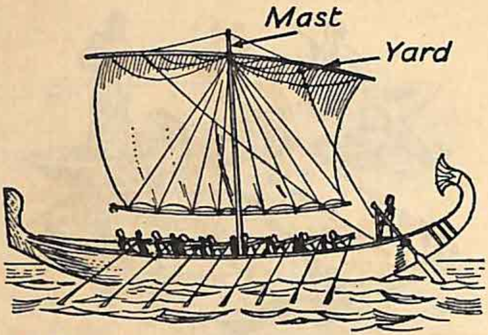


Fig. 13. An Egyptian galley fitted with mast and sail to help rowers.

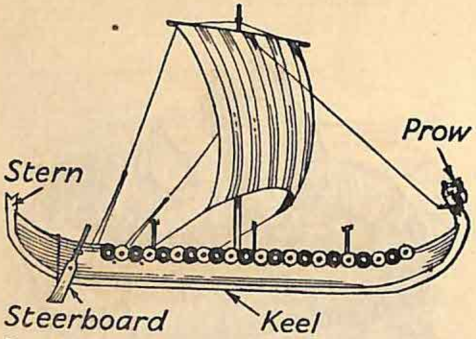


Fig. 14. A Viking longship of King Alfred's time. How is its hull shape better fitted for sea travel than the Egyptian galley?

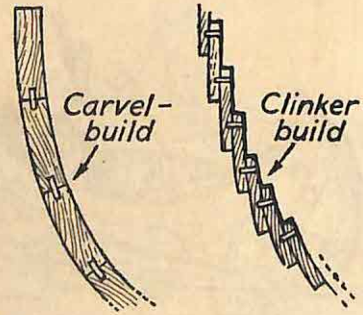


Fig. 15. Carvel-types were built from Mediterranean timbers which had to be cut to shape; clinker-types from northern timbers that could be bent easily.

oar by a much more easily managed rudder worked by means of a tiller.

The use of oars was gradually given up as ships grew in size and travelled to stormier seas than the Mediterranean. More and taller masts with many more sails took their place. By Columbus' time, that is about A.D. 1500, most ships had three masts.

During the next two hundred years ships grew in size, strength and seaworthiness. In the seventeenth century the high castles disappeared. The masts were now built up in three sections to greater heights than previously. This allowed more sails to be carried—usually three to each mast. In stormy weather the upper sections could be lowered to the deck. The six sails on the fore and main mast were square sails, *i.e.* they hung across the ship. The rear or mizzen mast usually carried a triangular sail, often hung fore and aft, *i.e.* along the length of the ship. In the eighteenth century yet bigger ships were built to trade with China and India. They had triangular headsails between the foremast and the bowsprit and staysails between the masts. The East India Company built its own type, called the East Indiaman, to carry both passengers and goods. They could be used as warships when there was need. One of the largest East Indiamen, the *Thames*, needed a crew of 130.

After 1815 American shipbuilders produced a new type of vessel which was so great an improvement that it threatened to drive the English type from the seas. This was the *clipper*, so called because it could clip or cut its way through the water. It had a narrow hull, knife-edge bows and a great spread of sail. It was specially designed for speed. Clipper ships held the records for fast voyages to China and Australia long after steamships were making these trips. They were the finest of all sailing vessels and perhaps the most beautiful ships ever built. They were slowly replaced by iron ships driven by steam. These were both cheaper to build and could be run by smaller crews, thus leaving more space for cargo or passengers.

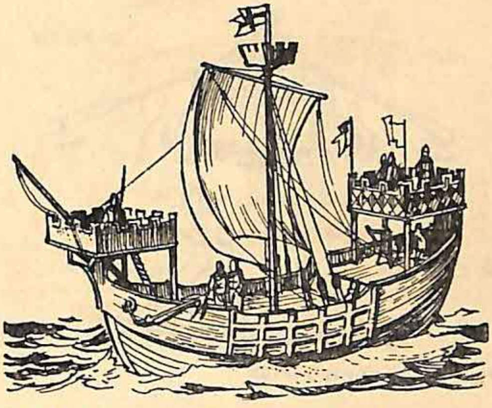


Fig. 16. A thirteenth-century English warship. Bowmen manned the two "castles".

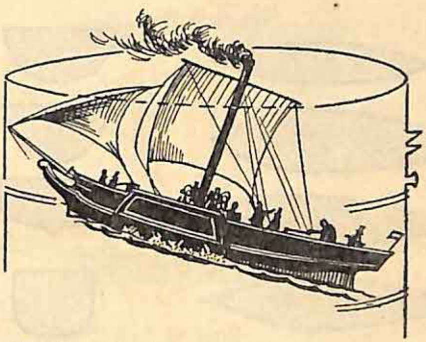


Fig. 17. How ships have grown in size. The *Comet* steamship (1812) would fit inside the funnel of the *Caronia* (1947).

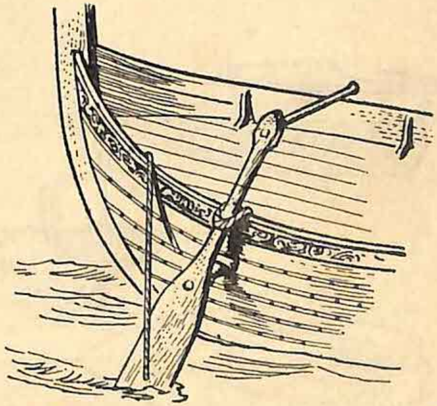


Fig. 18. The steering gear of a late Viking ship. The steering paddle changed to rudder and tiller.

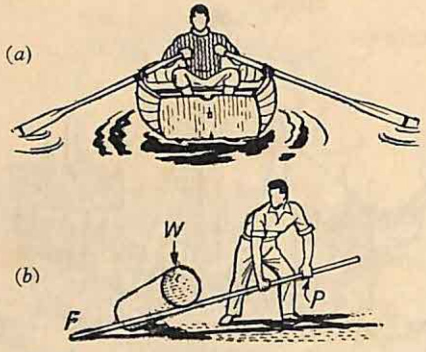


Fig. 19. The oar is a lever.

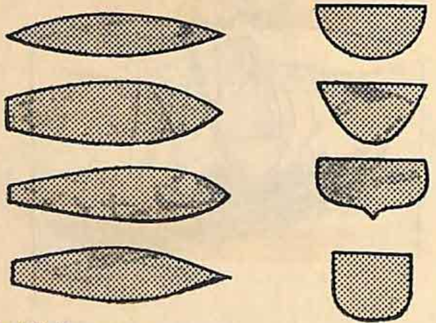


Fig. 20. Patterns for models of hull shapes.

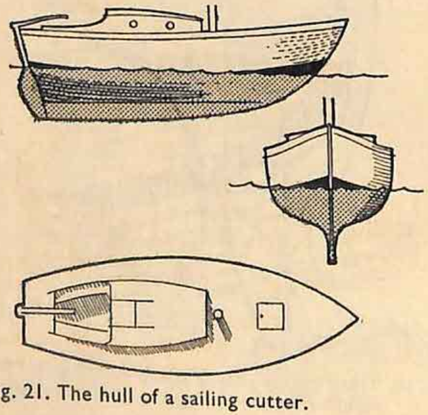


Fig. 21. The hull of a sailing cutter.

1 If you were fashioning a dug-out, what sort of wood would you choose: soft or hard, light or heavy? Why?

2 If you have read the story of *Robinson Crusoe* you will probably remember that he made himself a big dug-out canoe out of a tree trunk and that after spending a long time fashioning it he could never use it. Why was that?

3 What materials other than wood can be used in fashioning a canoe (*a*) for the framework, (*b*) for the outer skin?

4 A lever is a bar resting on a *fulcrum* (F). With it a *weight* (W) may be lifted by a *power* (P) to greater advantage than without it.

To lift a heavy beam a lever may be used. Examine the drawings in Fig. 19 and letter the parts in (*a*) to correspond with the parts that answer the same purpose in (*b*).

5 From soft wood or wax you can easily carve with a sharp knife models of ships' hulls. Fig. 20 shows some shapes worth trying. Test your models in a bath of water and find which are best for speed and which least liable to capsize.

6 Fig. 21 shows three drawings of the hull of a small sailing boat. Number the following parts: (1) bow or stem; (2) stern; (3) keel; (4) deck; (5) rudder; (6) tiller; (7) cabin; (8) forehatch; (9) starboard side; (10) port side.

7 Here are some uncommon names of boats: *balsa*, *catamaran*, *guffa*, *gondola*, *felucca*, *umiak*, *sampan*. Look them up in a dictionary or encyclopedia and name the country in which each is used.

8 It is generally cheaper to carry heavy or bulky goods by water than by road, rail or air. Can you think of any reasons for this? Ship carriage is especially cheap over long distances. Why?

9 On the plate in Fig. 22 are some of the foods you eat. Which of them may have been brought to this country by ship? Find the countries from which the ships may have carried them and the routes by which they travelled.

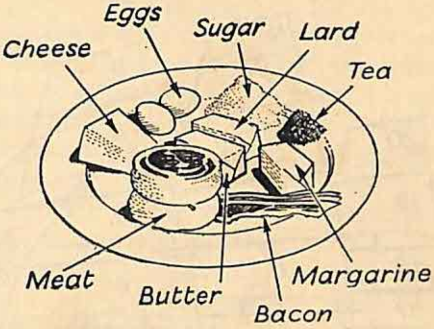


Fig. 22. Foods from overseas.

10 Find from a dictionary the meanings of the following sailing ship terms: *to furl a sail*; *to tack*; *starboard* and *port*; *windward* and *leeward*; *a lee shore*; *to spring a leak*; *standing rigging* and *running rigging*; *moorings*; *fender*.

11 A ship floats because the upward push of the water is greater than the downward push due to the ship's weight. When the ship is crossing waves this support is increased at some points and lessened at others. Look at Fig. 23 and say what may happen to a weakly built or overloaded ship in a storm?

It is difficult to make a strong long beam by joining short timbers together lengthwise. The Egyptian shipbuilders could only obtain short timbers and therefore could not make strong vessels. To overcome this weakness they used a strong rope truss (as shown in Fig. 24) fastened around the hull at either end. How did this help?

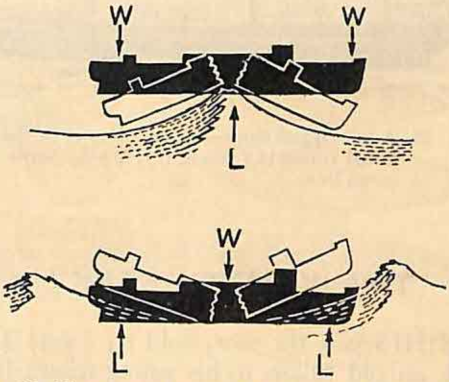


Fig. 23. How waves strain a ship. W—the weight of the ship presses downwards; L—the lift of the water presses upwards.

12 Here are some weather rules used by sailors. Test them by your own observations:

(i) High barometer, fine weather; low barometer, bad weather.

(ii) Rain before wind, hard blow; wind before rain, soon over.

(iii) Backing wind (i.e. changing south to east), bad weather.

(iv) Rounded clouds mean fine weather.

(v) Rosy sunset, fine weather; yellow or green sunset, bad weather.

(vi) Red sunrise brings wind and rain, grey morning brings fine day.

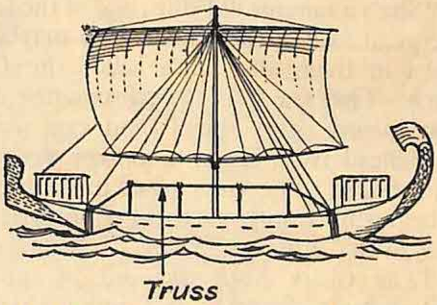
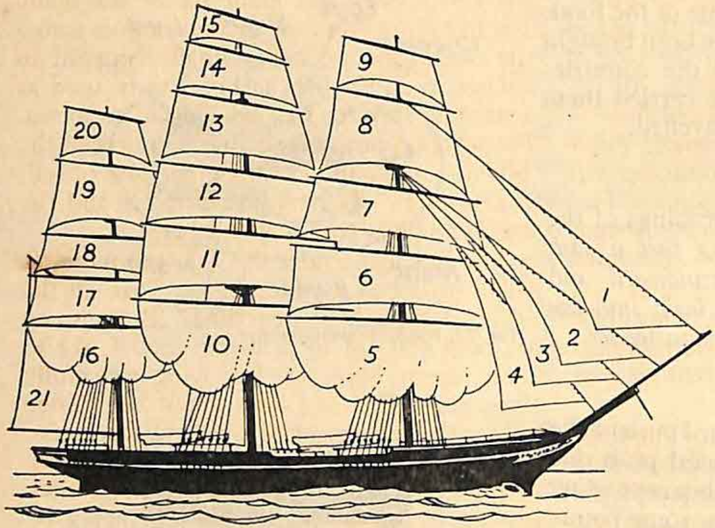


Fig. 24. A hogging truss fitted on an Egyptian ship to strengthen its weak hull when it was used at sea.



THE SAILS

1—Flying jib; 2—Outer jib; 3—Inner jib; 4—Fore topmast staysail; 5—Foresail; 6—Lower fore topsail; 7—Upper fore topsail; 8—Fore topgallant sail; 9—Fore royal; 10—Mainsail; 11—Lower main topsail; 12—Upper main topsail; 13—Lower main topgallant sail; 14—Upper main topgallant sail; 15—Main royal; 16—Cross-jack; 17—Lower mizzen topsail; 18—Upper mizzen topsail; 19—Mizzen topgallant; 20—Mizzen royal; 21—Driver or spanker.

Fig. 25. A full-rigged ship—the rig of most of the famous tea and wool clippers. The last British ship of the rig sailed round the world in 1934–6. Some of them reached speeds of 16 knots, *i.e.* as good as a modern cargo liner.

THE "CUTTY SARK"

THIS was the story told by Lame Tom, an old sailor, to his young friend John. John's father is the captain of a tramp steamer and the boy often came down to watch the ships in the river. Tom had promised to tell him about the great sailing ship that lay at anchor off-shore.

"She's a famous old ship, one of the last of the great sailing ships afloat and maybe the finest of them all. She's called the *Cutty Sark*. That's a queer north-country name that means short shirt. You can see her figurehead from here—a woman wearing a sort of shirt. The sailors used to say she was a beautiful young witch and brought bad luck to the ship.

"The *Cutty Sark* was one of the last British-built clippers. A London shipping firm wanted a fast boat that could beat the steamships just being used by a rival firm on the China run. These new boats were doing the 8,500 miles trip in about 60 days, but the coal they used took up a lot of room that might have been filled with cargo. They were nicknamed 'tea kettles' because they used steam and carried tea.

"The *Cutty Sark* was built on the Clyde and launched in 1869. Her bad luck had begun already because her builders went bankrupt on the job. Her hull has an iron framework underneath the wooden planking. You can see what lovely lines she has—a long narrow shape with a pointed bow. Under way, with all her sails set, she was as pretty as any racing yacht. She was built for speed, but she was too late for the China trade. The steamships took that.

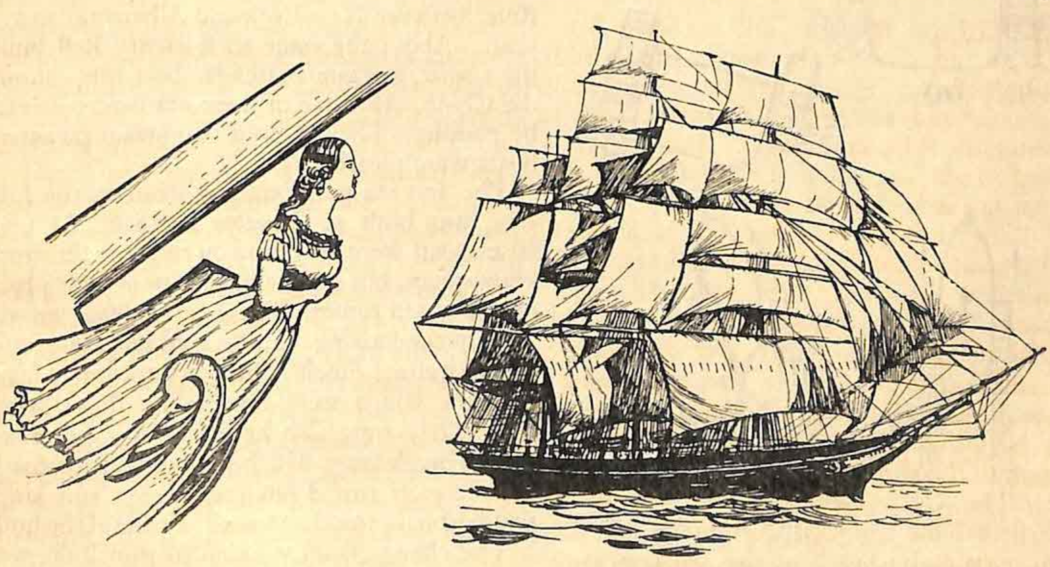
"The clippers lost it because the sailing ship was slower on the run, and in the tea trade speed was everything, for tea gradually loses its flavour when it is exposed to sea air. Thus the main thing was to get it to Britain as quickly as possible. To-day, of course, the trouble is got over by packing the tea in wooden chests lined with a thin sheeting of lead which makes them airtight.

"In 1872 the *Cutty Sark* changed over to the Australian wool trade like many other clippers. She soon made a name for herself. She once did 363 miles in a single day. Her best run home was done in 70 days. At that time the wool clippers raced home and hundreds of pounds were won and lost in betting on the winner. These races, though exciting, were no fun for the crews who slaved up aloft in the rigging, night and day, in all sorts of weather.

"After many adventures, mainly unpleasant ones, the ship was sold in 1895 to a Portuguese firm and till 1922 she sailed the seas under another name. In that year she was bought by an English skipper, re-named the *Cutty Sark* and made fit for sea again. For five more years she carried cargoes across the oceans before being finally brought to anchor in an English harbour, to be used as a training ship for lads wishing to go to sea. For several years now she has lain here in the Thames, a reminder of the great days of sail, of the tough officers who ruled her and the tougher sailors who manned her."

The old man ended his tale proudly. "I sailed in her as a young chap. Like all the others, I cursed her sometimes. But now we are both too old to face the seas, I like to come down here, see her lying peacefully there and tell young folks about her. They tell me they are trying to save her, to preserve her just as Nelson's ship the *Victory* is preserved at Portsmouth. I hope they manage it, for the like of her will never be seen again."

Figs. 26 and 27. Figurehead of the *Cutty Sark* and the *Cutty Sark* at sea. Length 212 feet. Tonnage 920 tons. She several times made the run home from China in 100 days. From Australia she logged runs of over 350 miles for several days in succession and several times did the run in under 75 days.



THE STEAMSHIP

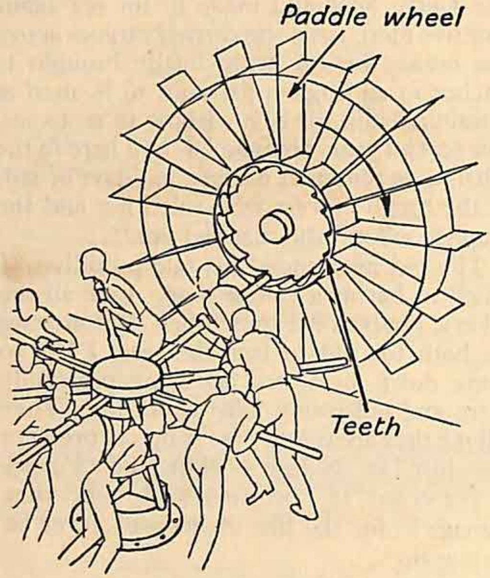


Fig. 28. How Savery's paddle boat was driven.

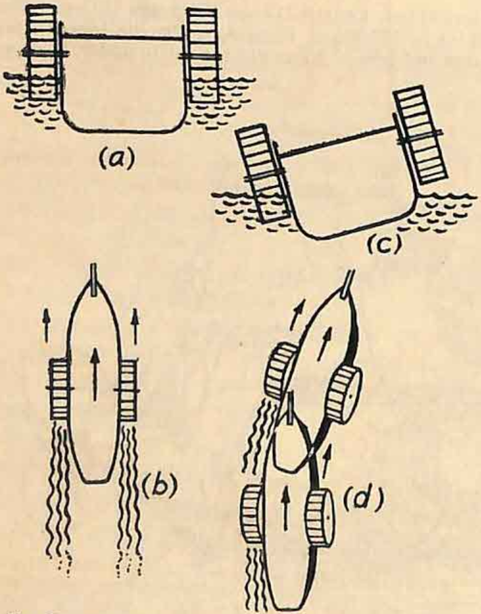


Fig. 29. In rough water if the boat tilts badly she may turn off course.

THE sailing ship reached its highest development with the clipper. For fifty years it fought for its existence against the new steamship. Gradually it was beaten for speed, economy and size.

The first power boat was designed by Martin Thomas Savery, an Englishman, about 1700. The paddle wheels in his boat were driven by means of a capstan worked by eight men. The ends of the capstan bars engaged with a toothed wheel on the paddle wheel and so forced it round in the water. But until James Watt invented the steam engine, the only sources of power for ships were the muscles of men and the winds.

James Watt's invention was soon applied to the driving of ships. The first successful steamboat was the *Charlotte Dundas*, built by a Scotsman, William Symington, in 1802. Robert Fulton, an American, saw Symington's vessel at work and on his return to New York had one built to his own design. It had an engine of 20 horse-power made by Boulton and Watt in their Birmingham works. This vessel, the *Clermont*, carried passengers on the Hudson River between New York and Albany for many years. About the same time Henry Bell built the *Comet*, a steam passenger boat that ran on the Clyde. All three of these craft were driven by paddles. They showed that steam-powered boats were possible.

The first sea-going trading steamer, the *Rob Roy*, was built at Glasgow in 1826. At first steamboats were only used on rivers or for short sea voyages, but gradually they took their place on the ocean routes. These early steam vessels were queer-looking craft for they had masts and sails as well as funnels. The sails were used whenever the winds were favourable, thus saving coal. They were also necessary in case of an engine breakdown, which sometimes happened. Tall funnels rose from their decks and large paddle-boxes stood out on either side of the hull.

The change from wooden to iron hulls was made very slowly though the first iron ship was built in 1821. At first it was thought that they could not possibly float. The *Cutty Sark* had wood planking over iron frames, but when Henry Cort invented the rolling mill which made it possible to roll big iron sheets then the shell too came to be made of iron. It soon became clear that iron ships were stronger in build, less liable to catch fire, and could be made much larger than wooden ships.

The next big change came with the introduction of the screw propeller. That it was superior to paddles was proved in 1845 by a tug-of-war between the *Alecto* paddle-steamer and the screw-driven *Rattler*.

The *Great Britain* designed by Brunel, a famous engineer, and launched in 1844 marked the victory of the new methods. It was bigger than any earlier vessel and driven by a screw propeller. He followed it by the *Great Eastern*, five times larger than any ship had ever been built before and for forty years it remained the biggest vessel afloat. It was 680 feet long.

Since then ships have increased in size and speed as better designed engines and hulls have been produced. Four types of engine are now in use. The older type *steam engine* is economical and very reliable. It is usually installed where high speeds are not required. In recent years oil has replaced coal as fuel. The *steam turbine* engine was introduced about fifty years ago. It is much used for passenger, fast cargo boats and naval craft. A few passenger liners are driven by *electric* motors. *Diesel engines* are rather like motor car engines but use oil instead of petrol. These engines are costly but they use little fuel. The *Queen Elizabeth*, over 1,000 feet long and of 84,000 tons capacity, marks the highest standards yet reached, though the newer *United States*, built in 1952 and of 53,000 tons, has beaten her for speed. Steel replaced iron long ago. This newest Atlantic liner is largely built of aluminium alloys which are lighter than even steel. Possibly future liners will be made much smaller and faster to compete better with aeroplanes.

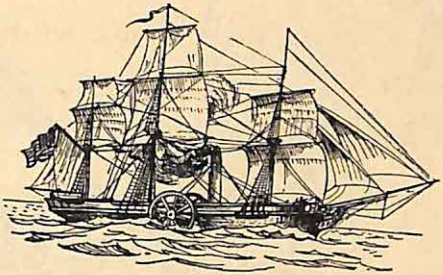


Fig. 30. The *Savannah*, an early steamboat, crossing the Atlantic in 1819. Her paddles were carried on deck most of the way!

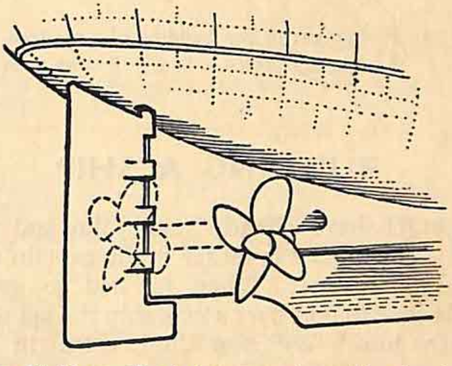


Fig. 31. Stern of a twin-screw steamship showing her rudder and propellers.

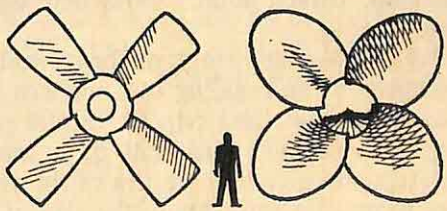


Fig. 32. The single propeller of the *Great Eastern* compared with one of the four propellers of the *Queen Elizabeth*. What is their diameter?

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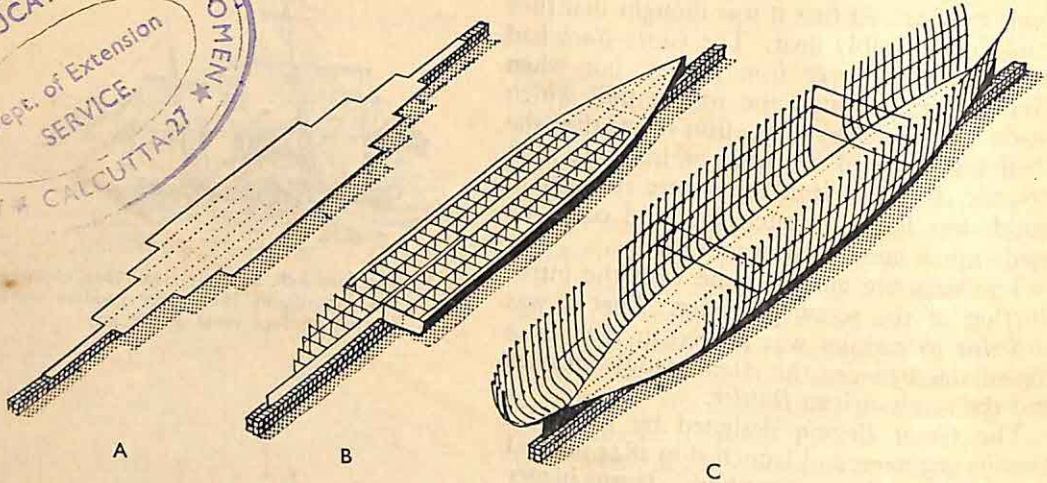


Fig. 33. Five stages in the building of a modern ship:
A—the keel plate is laid. B—the floor being built up. C—the frames, with knees fitted, are erected.

BUILDING A SHIP

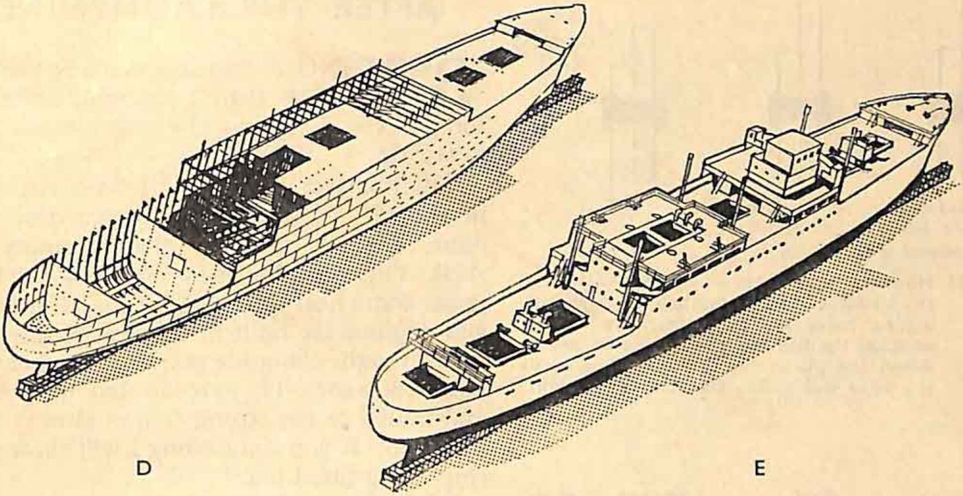
YOU have already met John and will remember his father is the captain of a tramp steamer. When he had to go to Glasgow to take over a new ship the lad went with him. We now find them in the manager's office of one of the great shipbuilding yards on the Clyde. They had just returned from seeing the new ship. John was thrilled with it and curious to know just how it had been built.

"How long has it taken you to build the ship," asked John. "And how was it built?"

"Well, it's a long story, my boy," said the manager. "The building of a modern ship takes a long time and calls for careful planning. The owners first call in a marine architect and give him an idea of the vessel they want. He must know the size of the ship, the speed expected and the kind of cargo it is meant to carry. He can then begin to draw his plans, just as for a new house. One drawing shows the shape of the ship as seen from above, another shows a side view and a third an end view (see Fig. 21). From these he prepares detailed drawings and instructions showing how the engine room, cargo spaces and cabins are to be arranged and what materials must be used. The shipowner can then take these to shipbuilding firms and find out how much they will charge for building the craft."

"Can the ship be built now?" asked John.

"No, not yet," continued the manager. "When the order has been placed, the builders first make a wax model of the hull. This is tested in a water tank so that some idea of its speed and its steadiness in rough water can be obtained. If these tests are satisfactory, *then* building can begin. The first tasks are the construction of the framework of the hull and the shaping and cutting of the steel plates to cover it. The framework is erected on a slipway, a long narrow strip of concrete in the shipyard sloping gently down to the water's edge. On either side of it is a row of



D—the outer plating, bulkheads, deck beams and deck plating are constructed. E—plating is completed and the main deck structures erected. The ship is now ready for launching.

cranes on steel towers to lift girders and plates into position as building proceeds.

"The first step is the laying down of the *keel*. This acts as a sort of backbone. Its long stiff girders are fitted together on wooden blocks resting on the slipway. The stem and stern posts and the frames or ribs are then built up from the keel. Meanwhile the *plates*, usually about 30 feet long and 5 feet wide, are got ready. In a huge room known as the *mould loft*, full-size plans of every frame and plate are laid down so that the steelworks, situated nearby, can supply them to the correct size and curved or bent to fit their places in the hull. Since the plates are fastened to the frames and to one another by means of rivets, holes have to be drilled in them so that when they are hoisted into place everything fits exactly.

"A slipway is a very noisy place when building is going on. Cranes lift the plates into position. Boys heat rivets red hot and throw them to the 'holder up'. He pushes each one through the holes in the plate and the frame or other plate behind it. Whilst he holds its head close up, his mate on the other side hammers the other end so that it spreads and flattens. When the rivet cools it holds the plates together very tightly. The edge of the plate is then *caulked*, that is it is hammered down with a chisel until it bites into the plate beneath. Sometimes the bulkheads and deckplates are *welded*, that is, instead of riveting, the two pieces of metal are put edge to edge and then heated so that they form a strong close joint.

"When the hull has been plated and the steel decks and bulkheads fitted, the ship is *launched*. Some distinguished person is usually asked to perform this ceremony. Many of the timbers which supported the hull have been removed and the slipway greased in readiness. When a lever is pressed the hull slides gently into the water. As soon as it moves a bottle of wine is broken over its bows and the ship is given her name. The shipyard workers cheer loudly as she floats for the first time."

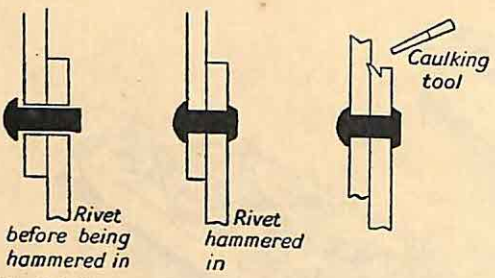


Fig. 34. How the ship's plates are fastened together: the red-hot rivet is pushed through the drilled holes in the plates; the riveter punches the head on the inner side and so draws the plates close; the caulker turns the edge and makes the joint watertight.

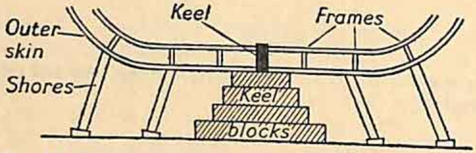


Fig. 35. The keel is laid on wooden blocks and the planking of the double bottom built out from it. Strong shores support the hull as it is built.

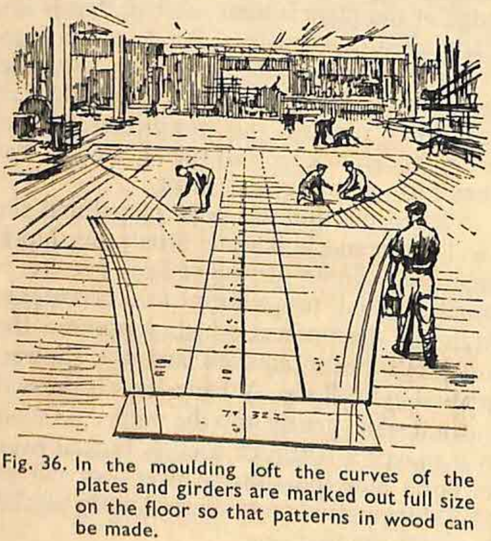


Fig. 36. In the moulding loft the curves of the plates and girders are marked out full size on the floor so that patterns in wood can be made.

AFTER THE LAUNCHING

"BUILDING a ship is a much more complicated job than I thought," admitted John. "Now I suppose the ship is ready to go to sea?"

The manager laughed. "I wish she was," he sighed. "There is still a great deal to be done, for she is little more than an empty steel shell. Tugs draw her away to a fitting-out berth in the water near the engine shops. Her boilers and engines are built in these workshops and then brought alongside and lifted on board by powerful cranes. They are lowered into position and bolted to the strong frames already fitted for them. If you come along I will show you a ship being fitted out."

John and his father got into a car with the manager and a few minutes later were standing alongside a vessel. Painters were busy on the hull, coating it against rust, and workmen seemed to be clambering all over the ship.

The main engines had already been put aboard and coupled to the propellers but the manager showed them some of the auxiliary engines standing on the quay. He explained that these were needed to provide electricity for lighting and cooking and other purposes. There were also pumps to supply fresh water wherever it was needed and to get rid of waste water overboard. Other machinery was required to hoist cargo in and out of the holds and to turn the great rudder which steered the ship on her course. John noticed that some of this machinery bore the names of firms other than the builders of the ship and asked about this. He was told these things were made by firms who specialised in each type of equipment. The anchors and chains for instance were made in Staffordshire, far away from the sea.

"Whilst the engine room is in the hands of the fitters fixing the main machinery," said the manager, "many men of many trades are busy elsewhere on the vessel. Plumbers are laying pipes to carry steam and water supplies wherever they are needed; electricians are fitting dynamos and motors and laying cables to supply lighting and heating; and carpenters are putting down deck planking and covering the walls of cabins and holds with panelling or boards."

"What are those men doing?" asked John, pointing to a group at work on the deck.

"They are fixing deck equipment, the anchors and chains, the masts and boats and the davits which raise and lower the boats, and the hoists and winches needed for handling cargo. Such things are bought from firms who specialise in their making. And those men there," said the manager, pointing to another group, "are fitting the portholes, as we call the round windows in the cabins. They also see to the glazing in the bigger deck cabins and rooms.

"Among the last tasks are the fitting of the ship's telegraph and radio systems. Finally, the decorating and furnishing of the rooms and cabins have to be done. On a big liner the laying of carpets, the fitting of furniture and the equipping of the kitchens is as big a job as in a great hotel.

"All the ship's lesser machinery and equipment is tested as it is fitted but her main engines await her trial run. This takes place when the work at the fitting-out berth is completed. Her boiler fires are lit and her main engines started. Several fussy little tugs draw her gently away from the dockside and guide her on her way down towards the open sea. Then they cast off their tow ropes and for the first time the ship moves out under her own power to face the seas. This is a thrilling and anxious time for builder and owner alike. We ask ourselves many questions: Will she answer her helm? How will she behave in bad weather? Will she make the speed we hope for? Will she——? There is no end to the questions that only the trial run can answer.

"We know she has been well built and she ought to sail perfectly, but one can never be quite sure. Builders and owners watch as she is put through test after test and her captain-to-be is especially critical—as your father was."

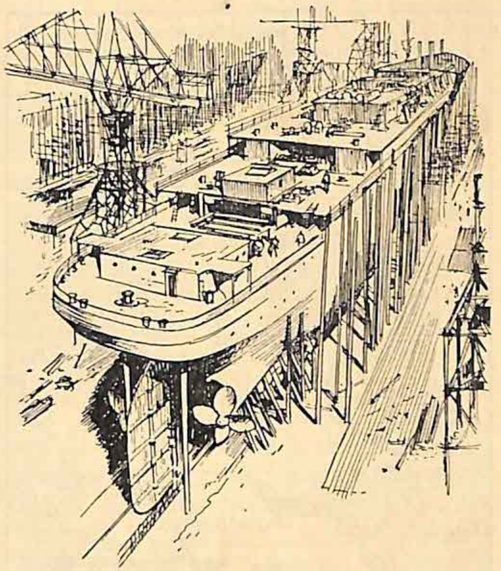


Fig. 37. A ship in the yard ready for launching. Many shores have been removed and the timbers on which it will slide to the water well greased.

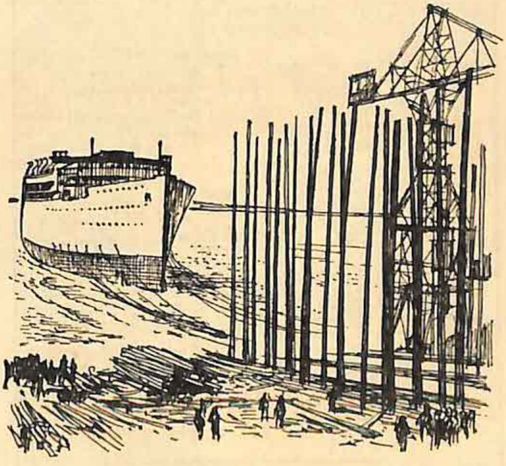


Fig. 38. The hull takes the water. Heavy chains dragging behind it slow it down until the tugs can take control and draw it to the fitting-out berth.

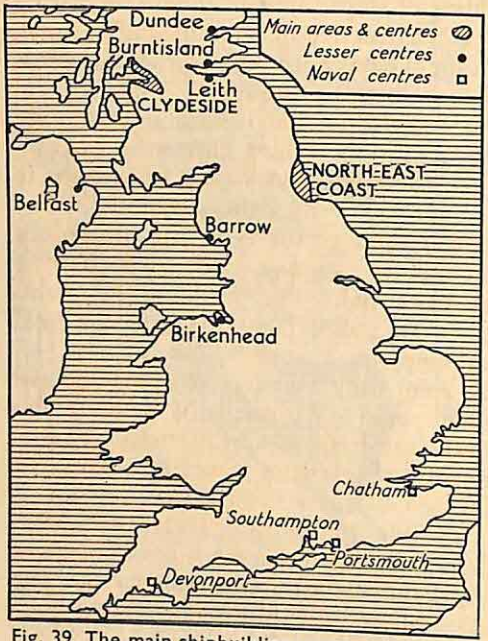


Fig. 39. The main shipbuilding centres.

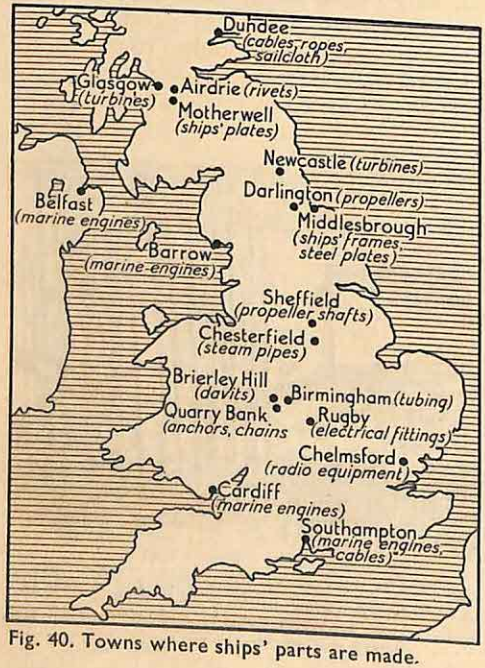

Dundee (cables, ropes, sailcloth)
Glasgow (turbines)
Airdrie (rivets)
Motherwell (ships' plates)
Newcastle (turbines)
Darlington (propellers)
Middlesbrough (ships' frames, steel plates)
Belfast (marine engines)
Barrow (marine engines)
Sheffield (propeller shafts)
Chesterfield (steam pipes)
Brierley Hill (davits)
Birmingham (tubing)
Quarry Bank (anchors, chains
Rugby (electrical fittings)
Chelmsford (radio equipment)
Cardiff (marine engines)
Southampton (marine engines, cables)

Fig. 40. Towns where ships' parts are made.

SHIPBUILDING IN THE UNITED KINGDOM

SINCE the English could only reach other lands by crossing the seas they had to learn long ago how to build ships. Oak forests provided the timber and the small vessels were built in sheltered bays or river mouths around the coasts. The fisherfolk made their own craft at many places. The old trading ports like Bristol and London, Whitby and Plymouth, built merchantmen, and some of the early ports on the English Channel supplied the first craft for the Royal Navy.

It was a long time, however, before British shipbuilders led the world. Dutch and French ships were better and, in the days of the clippers, North American craft were the finest. Even the first successful steamship was built in New York. When iron steamships came into general use, however, the shipyards of Britain soon took over the lead. Britain's world-wide trade needed many vessels. Her early start in making steam engines and other kinds of machinery trained her craftsmen in engineering. So British shipyards are still the best and busiest in the world. About one-third of the ships being built to-day are in British yards and at least one-third of those now afloat are British built.

There are four main reasons for the leading position of the United Kingdom in the shipbuilding industry: (*a*) her many deep, sheltered, tidal estuaries suitable for launching; (*b*) her iron and steel industry with works near the coast; (*c*) her own need of vessels of every kind; (*d*) the experience and skill of her ship designers and constructors.

Just over a century ago, when most ships were built of wood, the industry was centred very largely in the Thames estuary. With the coming of the iron ship, new yards were opened near the coalfields with their supplies of iron and steel.

To-day Clydeside is the most important shipbuilding centre, not only in Britain but in the world. Shipyards and docks line the banks of the estuary for twenty miles from Glasgow to Greenock. The work is carried on by some thirty firms. The best known of these is John Brown and Co. who built the *Queen Mary* and the *Queen Elizabeth*.

Next to the Clyde ranks the north-east coast which builds roughly one-third of British tonnage. The shipyards lie along the banks of the lower Tyne and Wear and the estuary of the Tees. Half a dozen towns in the area have shipbuilding as their leading industry. The most famous yards are on the Tyne, Armstrong's at Newcastle and Swan and Hunter's at Wallsend.

The great yards of Cammel Laird and Co. are at Birkenhead, on the Mersey opposite Liverpool. Barrow-in-Furness, like the Tyne, builds both naval and merchant ships. The last of the larger centres is Belfast in Northern Ireland where the firm of Harland and Wolff have their yards. Belfast has no local supplies of shipbuilding material but can easily obtain them from Cumberland and south-western Scotland.

Besides these important centres there are a number of smaller places busied about the building of ships, most of them specialising in the construction of one type only. Small craft for the navy are built in the dockyards at Chatham and Devonport. Trawlers and other vessels for the fishing industry are often built in the fishing ports such as Hull. These places need docks and workshops to do minor repairs to damaged ships in any case and some of the repairing firms do a little building of new craft to keep their men employed. The building of yachts and speedy motor boats is carried on near Southampton.

In comparing the sizes of ships and the amount built or owned in a particular country the term *tonnage* is used. This is a measure of space not of weight. Every 100 cubic feet of space enclosed in the ship is termed one ton *gross*. Thus the *Queen Elizabeth* is said to have a gross tonnage of 83,673, the *United States* of 53,329. The gross tonnage of a ship is not a good indication of the weight of cargo she can carry, *e.g.* a cargo boat of 5,000 tons *gross* may carry 7,000 tons weight of cargo, a liner of 20,000 tons *gross* only 10,000 tons *weight* of cargo.

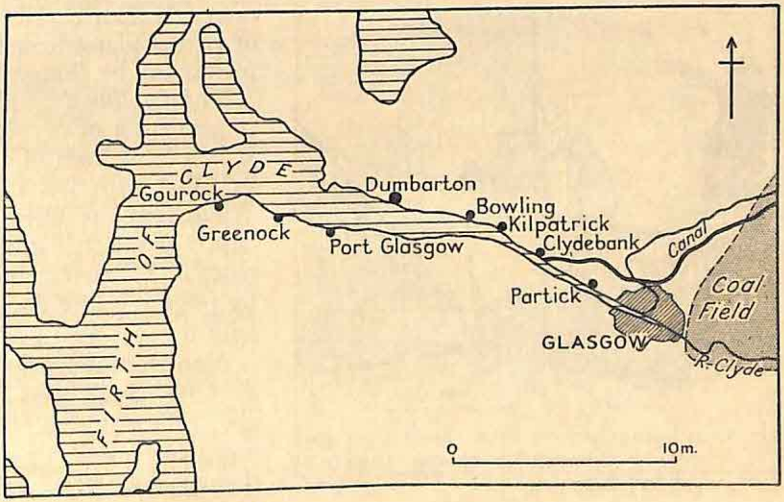


Fig. 41. Clydeside towns engaged in the shipbuilding industry. The fuel and steel needed are drawn from the coalfield and much of the machinery made in Glasgow. The *Comet* (1812) was built at Port Glasgow, the two *Queens* at Clydebank.

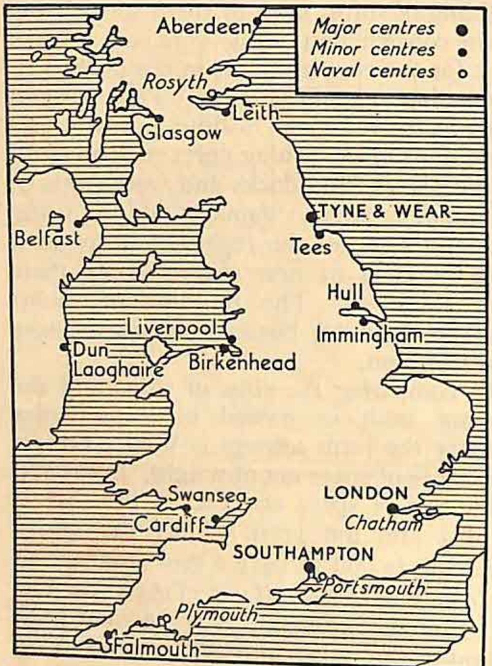


Fig. 42. Ship-repairing centres. Why are they more numerous than building centres?

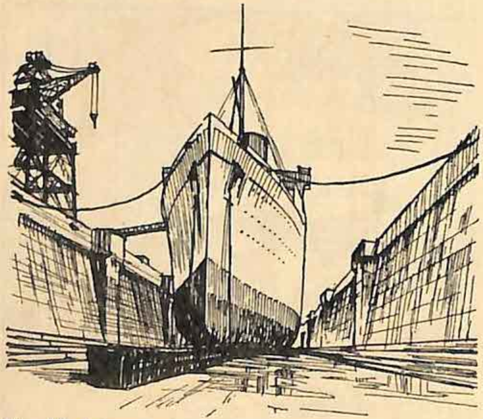


Fig. 43. A liner in graving dock. From a big dock over 50 million gallons of water have to be pumped out.

SHIP REPAIRING

ONE of the most important servants of every shipowning company is its Marine Superintendent. He has usually spent many years at sea, perhaps fifteen or twenty as captain. He knows from experience most of the company's ships. Any damage to a ship or any trouble with her engines or equipment is at once reported to him and he arranges for its repair. This is usually carried out when the ship reaches a home port. Much of the work, though not all, is carried out by the shipbuilding companies. Many of them keep stocks of spare parts for replacements, with workshops and men stationed in the trading ports ready to attend to the vessels they originally built.

At regular intervals, about once a year for the big passenger liners, each ship is taken out of service for a complete overhaul. All her machinery is tested, her hull and all her gear inspected, from cups and cutlery to boats and anchors. For this inspection and for any repairs to the hull and repainting below the waterline she must be taken out of the water. This may be done by means of a *dry* or *graving dock*. The dry dock is rather like a small dock of the ordinary type except that after the vessel has entered it the water can be pumped out. Workmen can then replace loose rivets or damaged or rusted plates from below the waterline. Propellers can be changed or their blades repaired.

The *floating dock* is used in ports where the construction of dry docks would be too costly. It is a dock built of steel chambers which can be filled with water or emptied as required. When they are filled the dock sinks until the depth of water is great enough for the ship to enter it. When the chambers are emptied again, by pumping, the dock rises and lifts the ship with it.

Many minor repairs can be done without dry docking. Such tasks as the replacing of a plate above the waterline, buckled perhaps by touching a dock wall, or of deck cabins or fittings damaged in a storm, can be done in quite a short time. Others, such as engine repairs, may call for nothing more than the replacement of worn parts. This kind of work is done most cheaply when the vessel reaches her home port at the end of a voyage. In every large port an army of shipwrights, fitters, boilersmiths, electricians and carpenters is constantly at work carrying out running repairs on the ships in dock for unloading or loading. These are hurried through so that a ship need not be taken off her regular run.

Ship repairing and shipbuilding are not usually carried on at the same place. The owner wants his vessel back at work as soon as possible and to avoid the cost of sending the ship perhaps two or three hundred miles for repairs. The builders do not want valuable berths occupied by ships needing only a little work to fit them for service again. For these reasons every important port has repair yards and workshops as near the unloading points as possible. Shipbuilding yards require much space, both on land for the construction of the hull and on the waterway for the fitting-out berths and the movement of partly built vessels. They are best suited by situations away from the busy trading areas. Modern shipbuilding centres such as Barrow-in-Furness and Belfast and growing centres like Dundee occupy such positions. The Tyne yards on the other hand have suffered from lack of space.

The north-east coast is the leading ship-repairing area in Britain and has many dry docks for the purpose. Tyneside is the great exception to the rule that building and repairing are done in different places. London and Southampton are naturally great centres for repairs. Cardiff, Hull and Liverpool also have facilities for this work. When new building orders are few, the Clydeside yards undertake repairs to keep their men at work and berths occupied.

The Royal Navy has its own special dockyards where battleships, destroyers, cruisers, aircraft carriers and submarines undergo repair and refitting. The chief naval dockyards are at Portsmouth, Chatham and Plymouth.

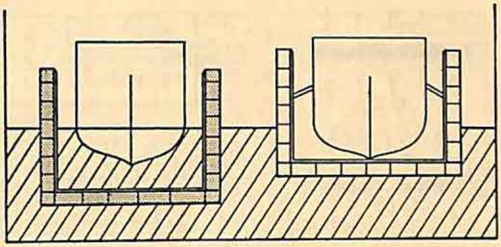


Fig. 44. How the floating dock lifts a ship.

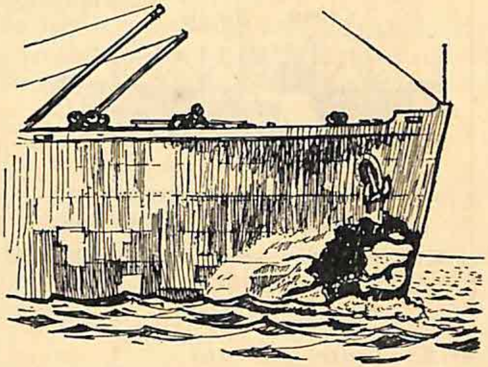


Fig. 45. A job for the repairing yard. Plating on the bows has been torn away. Why did the ship not fill and sink?

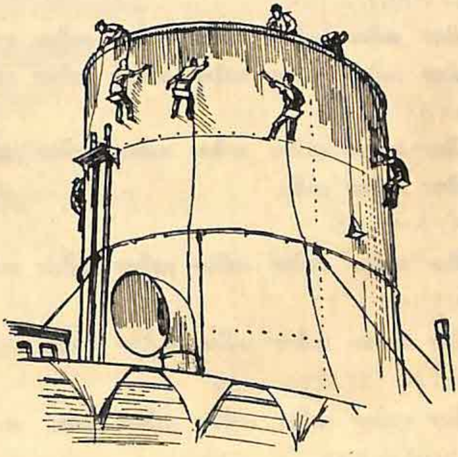


Fig. 46. Painting the funnel of a big liner.

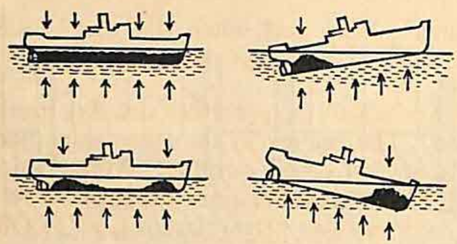


Fig. 47. Good and bad loading.

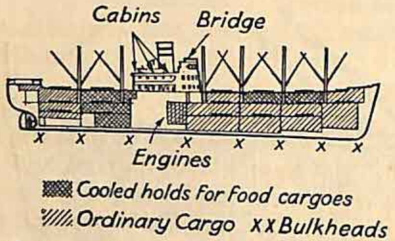

Cabins
Bridge
Engines
▩ Cooled holds for food cargoes
▨ Ordinary Cargo XX Bulkheads

Fig. 48. A cargo liner, showing the main bulkheads.

1 Ships were built first of wood, then of iron and later of steel. The latest vessels (*e.g.* the *United States*) use much aluminium alloy in place of steel. What are the chief advantages and disadvantages of each material?

2 Some early ships "broke their backs" in crossing high waves. One of the earliest turbine-driven British torpedo boats did this when driven at high speed through a storm in the North Sea. What do you expect was the cause of this? (Look at Fig. 23.)

3 The hull of a ship is divided into sections by building strong, vertical, watertight divisions from side to side of the vessel. These are called bulkheads. Why is this done?

Additional bulkheads are often fitted if a bulk cargo such as grain or coal, which is liable to shift in a storm, is to be carried. Why?

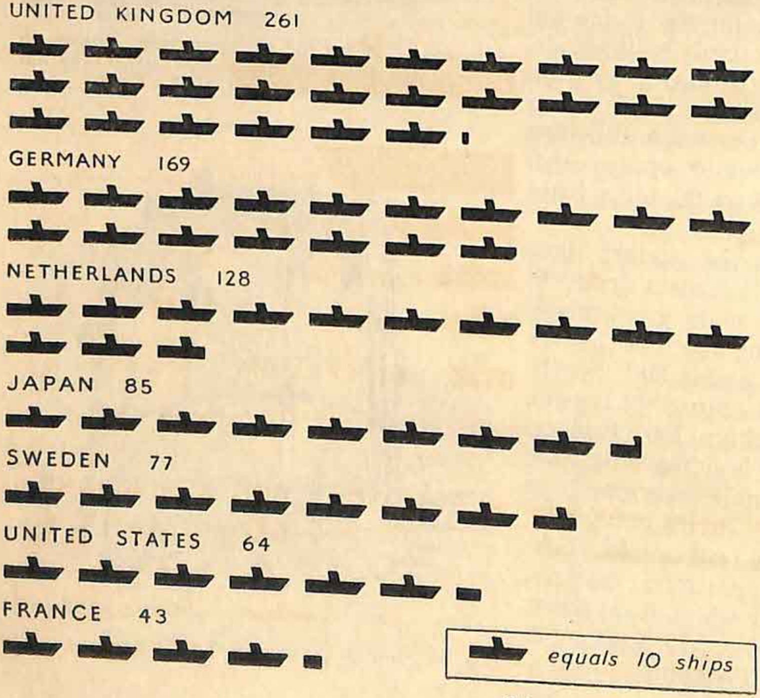


Fig. 49. The number of ships launched in 1951 in the seven most important building countries. Fig. 50 shows the total tonnage of those ships. Can you suggest why the order differs in the two cases?

Four reasons for the United Kingdom's leading position are given on p.20. Which of those reasons help to explain the inclusion of the other six countries mentioned here?

4 In loading cargo care is taken to spread its weight, as far as possible, evenly along the whole length of the ship. Why would it be dangerous to put most of the load at either of the two ends? Comment on the way in which the cargo in each of the ships in Fig. 47 has been stowed.

5 The chief countries owning *tankers* are, in order, United States, United Kingdom, Norway, Panama. Give one reason why each of these countries should be specially interested in this kind of ship.

6 Look at Figs. 39 and 41. Why are shipbuilding centres usually found on estuaries? What conditions are necessary to make the estuary suitable for the purpose?

7 Can you find an explanation why Norway is so high in Figs. 51 and 52, but does not appear in Figs. 49 and 50? Why do shipowners *register* ships under the flag of Panama? Why and when did the U.S.A. build most of the ships shown in Fig. 51?

8 Most ships to-day are either steam or motor driven. The boilers in the steamships may be either coal or oil burning. Motor ships usually have diesel engines using oil, where the motor car uses petrol. In 1914, 97% of all tonnage was coal burning, in 1939, 45%, in 1951 only 19% depended on coal. Why has the proportion of coal-consuming vessels fallen so heavily?

In Norway, Sweden and Denmark two-thirds or more of the shipping is motor driven, in Britain only a little over one-third. Why?

9 Fig. 51 shows the tonnage of shipping registered in the leading countries. About half the United States total consists of vessels built during the Second World War but now lying unused in harbour. Which countries appear to have more ships than are necessary for the trade of their own land.

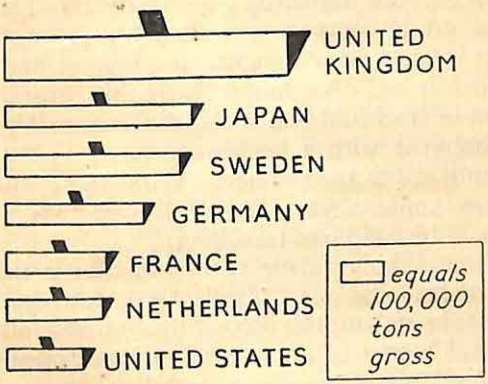


Fig. 50. Tonnage of ships launched 1951.

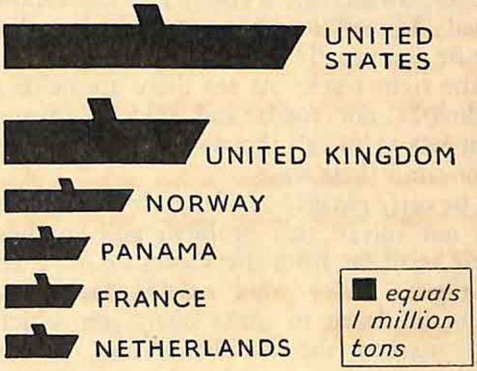


Fig. 51. Tonnage of all ships registered in 1951.

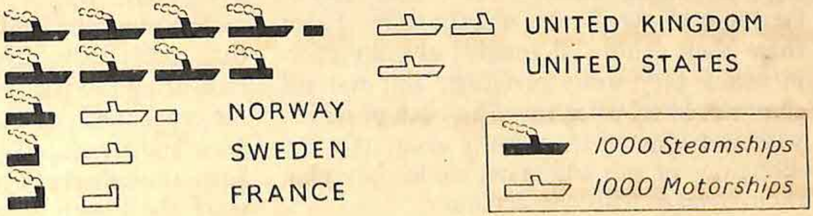


Fig. 52. Numbers of coal- and oil-burning ships and motor ships 1951.

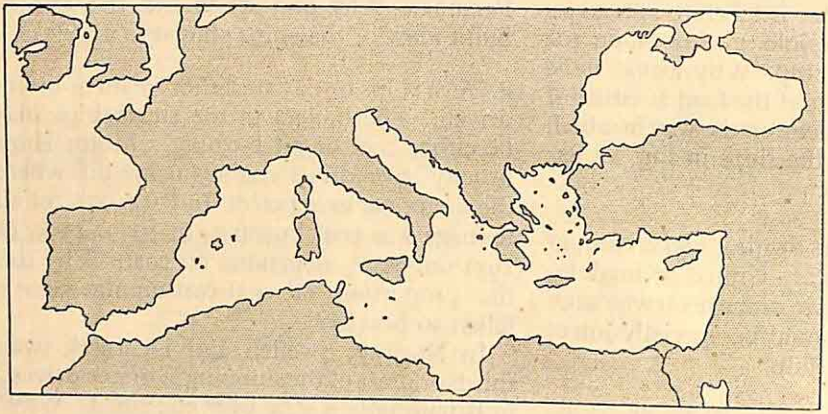


Fig. 53. A fourteenth-century sailors' chart drawn before the compass was in common use.

FINDING THE WAY

THE traveller by land finds his way from place to place by means of landmarks such as hills and river crossings, woods and villages. In a civilised country he can follow a road and read the signposts. If he loses his way he can usually find someone to put him on the right track. At sea there are neither landmarks nor roads and seldom anyone from whom to ask the way. How then do sailors find their way?

The early navigators of the Mediterranean had not solved this problem and so they rarely went far from the shores or travelled by night. They were *coastal navigators.* They did learn to make charts on which they marked the headlands and islands which served to guide them and the harbours where they might find shelter overnight or during storms. They soon discovered how to use the sun and the stars. From them they could tell roughly the direction in which they were travelling. But not till centuries later, when they had been provided with instruments to measure accurately the directions of sun and stars, could they plan their voyages with any accuracy.

In cloudy weather the stars and the sun were hidden and so this help failed them. This difficulty was not overcome until land travellers had learned from the Chinese the use of the *loadstone* (*i.e.* leading stone) and brought the knowledge to the west. The first crude compass was simply a piece of this strange stone hanging in a loop of hair. When it had been found that a thin strip of iron or steel could be made into a magnet by rubbing it with a loadstone, better instruments were soon made. With these the sailor could always know the direction in which his ship was travelling.

The Vikings made their way across the northern seas to Iceland, Greenland and Canada without the help of the compass, but it had been in common use for over a century before Columbus crossed the Atlantic in 1492. His voyage marked the beginning of ocean navigation. By his day ships had become more seaworthy and more easily managed than previously. He had instruments for measuring the position of sun and stars, *e.g.* the cross staff and the astrolabe. The sand-glass and measured candles enabled him to keep a rough check of the time and so estimate the length of each day's run. Long, deep-sea voyages had not been attempted before his time because not enough was known of wind directions. The real discovery Columbus made was that the trade winds off the North African coast would carry his ship westward and, if he then made his way north, westerly winds would bring him back to Europe.

What earlier Portuguese sailors had found out about the winds of the South Atlantic made it possible for Vasco da Gama to reach the Cape of Good Hope in 1497. He then followed the coast of Africa east and then north until he found the help of an Arab sailor who knew the winds of the Indian Ocean and guided him to India.

Da Gama crossed from Africa to India in 23 days, averaging 93 miles per day. The return voyage lasted three months and the average daily run was only 25 miles. The monsoon wind helped him towards India but hindered the return to Africa. Later travellers on the same route discovered that the wind reversed its direction a month or two later in the year and so made the westward journey more quickly.

So long as ships depended on sails the ocean routes they followed were fixed by the winds. By the time of steam power the methods of navigation had improved until it was possible to tell exactly where a ship was at any time and to keep closely to any track which had been laid down. Now wind directions are unimportant and courses are nearly always laid down along the most direct routes from port to port. This not only shortens the voyages but also saves fuel and stores. A captain who strays from these routes without very good reason will soon be in trouble with the owners of his ship.

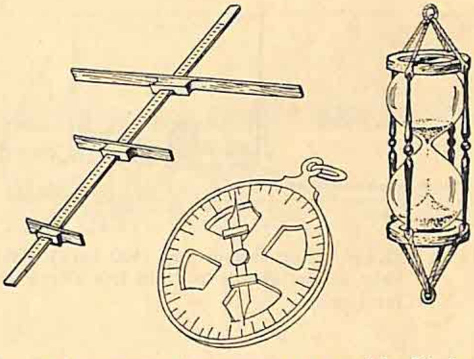


Fig. 54. Navigation instruments as used by Drake: on the left a cross staff, in the centre an astrolabe, on the right an hourglass or sandglass.

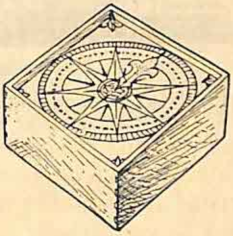


Fig. 55. An eighteenth-century mariner's compass.

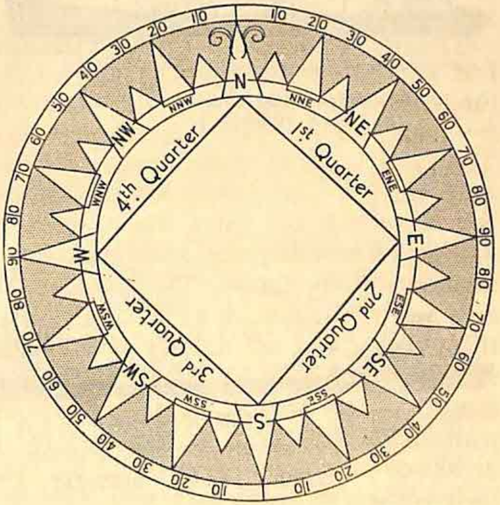


Fig. 56. A compass card. Divisions of 10° are marked for each quarter and the thirty-two "points" indicated. Before the days of the compass the Vikings used what are here shown as the quarters as their main directions (*i.e.* instead of north, south, east and west their primary directions were what we should now call north-east, etc.).

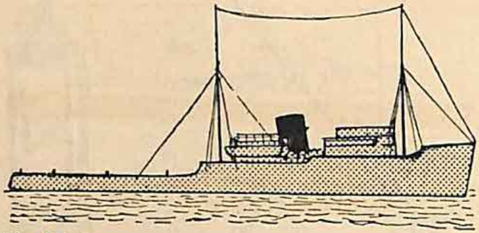


Fig. 57. Ocean going salvage tug (600 tons). Has very powerful engines and low afterdeck for towing.

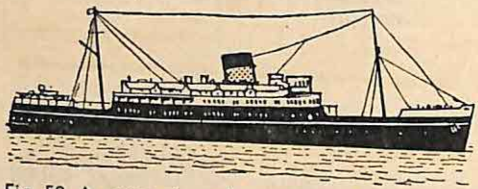


Fig. 58. A cross-channel passenger boat. (2,500 tons, 22 knots.)

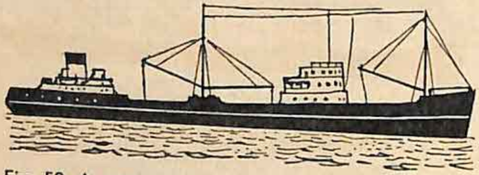


Fig. 59. A motor-driven coaster. (1,800 tons, 10 knots.)

THE MERCHANT NAVY

SHIPS engaged in trade make up the Mercantile Marine, or as it is more often called, the Merchant Navy. The British Merchant Navy consists of over 3,000 vessels with a total tonnage of about 12½ million tons gross. Just as we have different vehicles—cars, buses and lorries—for different tasks on land, so ships can be divided into classes according to the work they do.

The biggest ships are *passenger liners*, 15,000 to 80,000 tons gross, though there are many smaller liners of 5,000 to 8,000 tons. They follow fixed routes and work to a time-table. Their main purpose is to convey passengers as quickly as possible from port to port. Most of them carry mail (mainly parcels nowadays) and valuable cargo. Many of them are fitted for the carrying of "clean" cargo that can pay their high charges. Thus South African liners carry fruit and gold, and ships in the Far Eastern trade bring in tea and tin and take away cloths and electrical goods. Because of their size they can only use deep and roomy harbours. The North Atlantic liners are the biggest of all, many of them so big that they could not be used on the Suez Canal routes. The most important passenger routes from Britain are (*a*) to New York, and to Canada up the St. Lawrence River; (*b*) through the Mediterranean to India and the Far East, and to Australia; (*c*) to South Africa. Just over 250 British ships are passenger liners.

Cargo liners, like passenger liners, follow fixed routes and run to a time-table. They

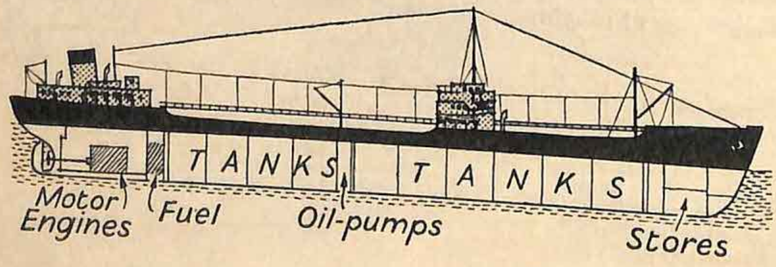


Fig. 60. A small tanker lay-out. (10,000 tons, 16 knots.) In which of the ships on this page are the engines in the stern. Why?

are smaller ships, mostly 6,000 to 10,000 tons gross, and somewhat slower. They carry few passengers, many not more than the 12 allowed to any ship and some none at all, for their main work is to carry cargo. They call at the smaller ports, wherever regular shipments of produce can be picked up or discharged. Such boats are used in the South American meat trade and the West Indian fruit trade, but many carry general cargo. British cargo liners number about 850.

Tramp ships are so called because they follow no regular routes. They often call at out-of-the-way ports where there are no cranes on shore and so they have to be fitted to load their own cargoes. Their special task is the carriage of bulky raw materials, such as ores, coal and timber, and of heavy manufactured articles, such as railway engines and coaches. They are usually under 10,000 tons gross. The number under British ownership has decreased to about 450, many lost during the war not having been replaced and the cargo liners taking more and more of their trade.

Tankers are ships specially designed to carry liquid cargoes, mainly oil. Mostly about 10,000 tons gross, the newest tankers approach 40,000 tons. Britain is the main tanker-owning country with some 460 vessels totalling nearly 4 million tons gross. They are usually kept on one run so they might be regarded as special cargo liners.

Deep-sea ships are now very costly to build. A new cargo liner generally costs her owners over £1 million and a passenger-cargo liner recently built actually cost over £4 millions.

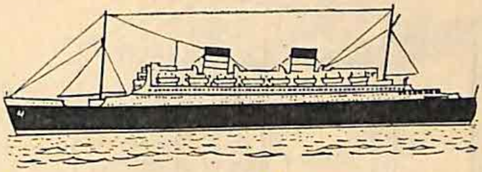


Fig. 61. A passenger liner of Atlantic type. (35,000 tons, 20 knots.)

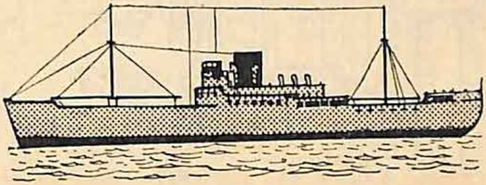


Fig. 62. A West Indian fruit boat. (3,500 tons, 15 knots.)

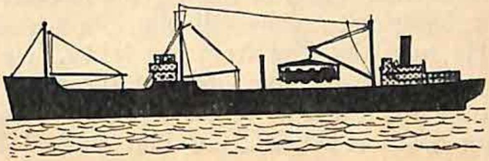


Fig. 63. A heavy freighter or cargo boat loading a locomotive. Her derricks can lift up to 100 tons. (7,000 tons.)

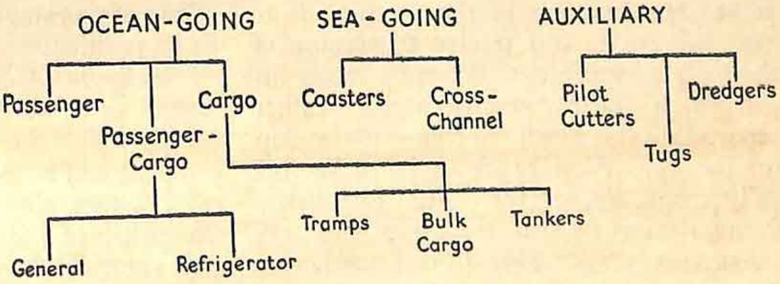
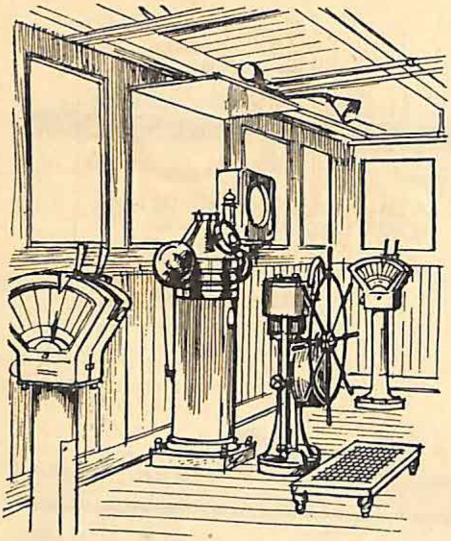


Fig. 64. The chief types of ship. Sort the seven ships into their groups.



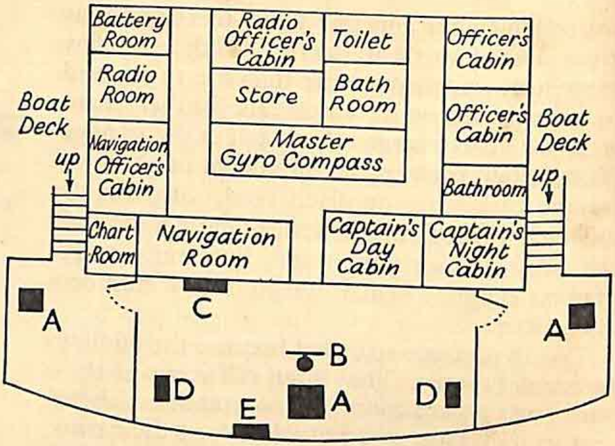


Fig. 65. The bridge. AAA—compasses all controlled by the master gyro-compass. B—wheel. C—echo-sounder. DD—engine room telegraphs. E—radar scanner.

THE SHIP AT SEA

WHEN the local pilot has guided the ship out of port her own officers take command. Chief of these is the Master, or as landsmen usually call him, the Captain. He rules the ship from the *bridge*. He is responsible for the safety of the ship, its passengers, and its cargo. Every happening on board is reported to him and all are under his orders, passengers as well as crew. He is really never off duty and may be called at any hour. He stays on the bridge so long as the pilot is on board. At sea, however, he hands over to the duty officer when he leaves the bridge and receives his report immediately he returns to it. His first job in the morning is to visit the bridge and receive an account of the night's happenings. Then he meets his navigation officers, receives radio weather reports and lays down the course of the ship for the day. After breakfast he makes his daily inspection of the ship. Frequently during the day he visits the bridge and pays a final visit late at night. In bad weather or in any serious trouble he may stay there for many hours.

The officers of the ship fall into two groups—the deck officers, who are responsible for navigation and general care of the ship and its contents, and the engine room officers, who are responsible for the engines and machinery. The *Chief Officer* or First Mate is the senior deck officer. He is in charge during the Morning Watch and the two Dog Watches. (See Fig. 68.) The Second Officer takes his place for the Middle and Afternoon Watches and the Third Officer takes the other two. A big liner may have as many as eight of these watch-keeping officers. The Chief is responsible for the proper loading of the ship, for its navigation and for the taking of morning and noon observations to fix its position.

The Radio Officers, two on a big ship and several on an ocean passenger liner, do not usually follow the normal watches. Besides receiving and sending messages and weather reports, they play an important part in the navigation of the ship. The maintenance and control of such instruments as the direction-finder and the new radar devices are part of their work. Radar enables the captain to "see" his way through fog or into harbour in the dark, showing on a kind of television screen any ship or other object ahead of him. The direction-finder helps in fixing the position of the ship. The echo-sounder has replaced the old method of finding the depth of water beneath the ship by means of the lead-line. It is another radio device by which the depth is shown on a dial or marked on a moving strip of paper.

Below decks in the engine room there is a similar organisation. The *Chief Engineer* is directly responsible to the Master and like him keeps no regular watches. He has at least three juniors—a First Engineer who keeps the same watches as the Chief Officer on deck, and Second and Third Engineers for the other watches. Their first responsibility is the main engines which drive the vessel, but there are many other machines to be watched too. There are the dynamos supplying electricity, the condensers which provide fresh water, the fans that drive fresh air (warmed or cooled as required) through cabins and holds, and the pumps which keep the ship dry.

Bigger ships carry other officers, often called day officers because they do not keep watches. If there are more than one hundred people on board the ship must carry a Doctor. Big passenger ships have a Purser to look after the ship's business. He will have a Chief Steward to see to catering, cooking and other "household" duties.

The crew is, of course, divided in a similar way. Deck-hands are in the charge of the Boatswain, the Chief Officer's right-hand man. The ship's Carpenter has little to do with woodwork. His main jobs are to watch the safety of cargo in the holds and its protection against sea water. The Cook is a day man with his own staff. The Donkeyman is the Chief Engineer's helper, mainly looking after deck machinery. Except for these men in charge and the stewards who look after passengers' needs the deck and engine room crews all work by watches.

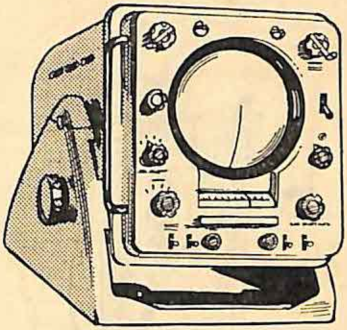


Fig. 66. A radar scanner. Other vessels or obstructions in the path of the ship are seen on the screen even in darkness or thick fog.

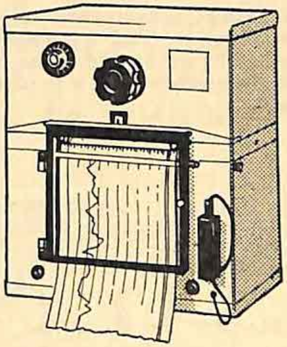


Fig. 67. An echo-sounder or depth recorder. It traces on the moving paper a record of the depth of water beneath the ship.

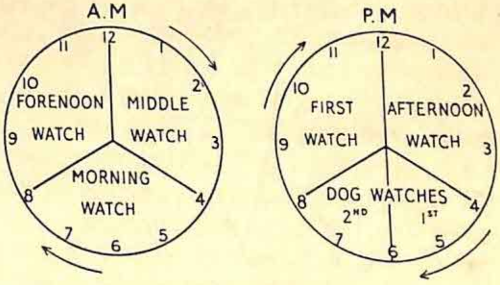


Fig. 68. How the 24-hour day is divided into five watches and two dog watches. The dog watches give the men a change of watch every day. Fig. 81 shows how.

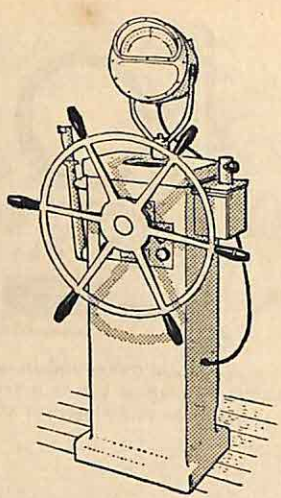


Fig. 69. "Iron Mike", the automatic steersman with vertical compass dial. It can be set to keep the ship on any desired course or freed so that the quartermaster is in control at the wheel.

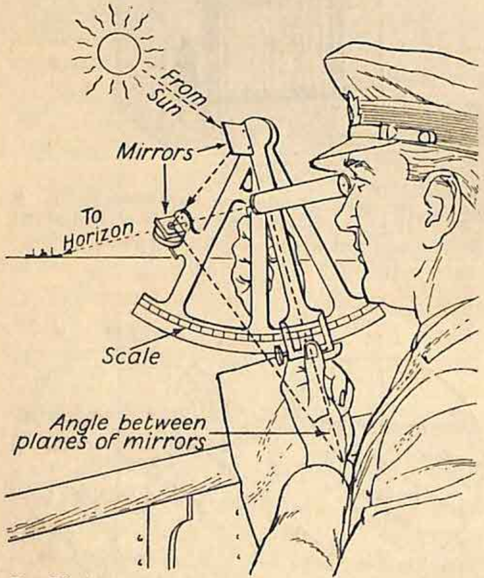


Fig. 70. Using the sextant to find the sun's altitude (*i.e.* the angle between the sun and the horizon) at noon. The horizon is seen through the tiny hole in the lower mirror while the sun is reflected in the mirrors.

FIXING THE SHIP'S POSITION

A SHIP in danger of sinking or in other serious trouble at sea sends out an "SOS", or call for help, over its radio. How do the ships hurrying to her assistance know where to find her? And how does a ship know when she is on her true course and not being carried off it by wind or current? The answer to both questions is the same. The officers on board keep a constant record of her position. Anyone can find a place on an atlas map if he knows its latitude and longitude. The ship's officers find their latitude and longitude and can then mark on their charts just where they are and read off the direction they must steam to their destination.

Every deep-sea ship must carry a compass, a sextant, a chronometer and a book of tables called a *Nautical Almanac*. With these a navigator can find his position and take a ship anywhere. Ships to-day carry many other instruments to help the navigator, but all these depend on a supply of electricity, and ship's dynamos sometimes fail. The *compass* gives direction of course and with it the steersman can keep the ship along the course given to him. The *sextant* is an instrument with which to measure the angle between a line from the ship to the horizon and one from the ship to the sun or a star. This angle is called the *altitude* of the sun or star. The *chronometer* is simply a very accurate watch set to keep Greenwich time. It can be checked by the Greenwich time signals sent out every few hours by radio.

The simplest way to find one's *latitude* is to measure the altitude of the Pole Star, for that angle is the same as the latitude—0° at the Equator, 90° at the Pole. A more useful way is to use the sextant to find the altitude of the sun at noonday, that is when it reaches its highest point for the day. This is always done on board ship. It gives the navigator two important pieces of information—the altitude of the noon sun and the exact time of noon at that place. From the first the latitude can be found, from the second the longitude.

Everyone knows that the height of the midday sun varies, being high in summer and low in winter. The angle between a line to the sun from the centre of the earth and the plane of the Equator is called the sun's *declination*. The tables in the *Nautical Almanac* give the noon declination for every day in the year. On June 21st this is $23\frac{1}{2}^\circ$. The altitude is read from the sextant. Suppose this angle is 40°. Then the latitude of the ship is $90^\circ - 40^\circ + 23\frac{1}{2}^\circ$, *i.e.* $73\frac{1}{2}^\circ$. (Fig. 71.)

To find the *longitude* one must remember that the Earth spins round completely, from west to east, *i.e.* through 360° in 24 hours, or through 15° in each hour. If therefore the sun reaches its highest point as seen from the ship when the chronometer shows Greenwich time to be 2 p.m. its longitude must be 30° W. If the chronometer showed it to be 11 a.m. its longitude would be 15° E. (Fig. 72.)

Other ways of finding the ship's position are by "dead reckoning" and by bearings on places whose positions are known. Each day there is entered in the log the distance of the ship's run and also its course and any changes of course. Having started from a known point these figures make it possible to mark the position daily. In the other method the directions of known places marked on the chart are determined by the compass if they are in sight, by the radio direction-finder if not. (Fig. 73.) Neither method is very accurate but each is useful to check possible errors in calculating the position by other means. In one very modern method, only in use over a few areas as yet, the position can be seen on a map of the sea, the ship appearing as a tiny moving speck of light on the map as shown on a kind of television screen.

The inaccuracy of early maps was due to the fact that the navigators of the time had no means of determining their position exactly. Latitudes were easy to determine but longitudes could not be fixed accurately until reliable chronometers were available late in the eighteenth century.

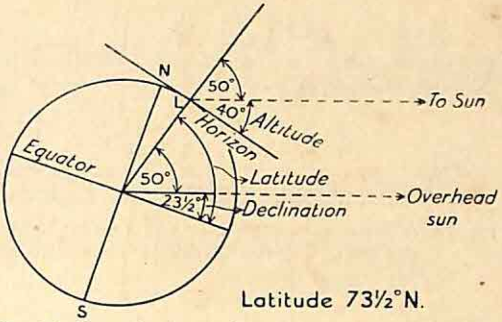


Fig. 71. How the latitude is found from the sun's altitude at noon.

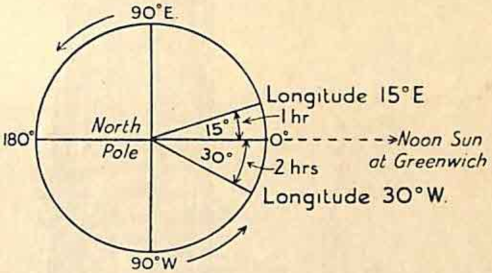


Fig. 72. How longitude is calculated by observing the time of noon as given by the ship's chronometer (*i.e.* Greenwich time).

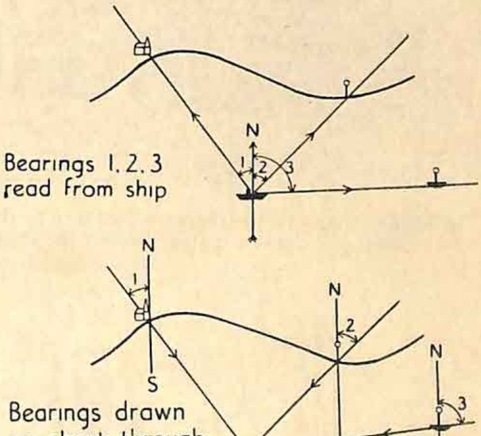

N
1
2
3
Bearings 1.2.3 read from ship
N
1
S
N
2
N
3
Bearings drawn on chart through objects observed
S
S

Fig. 73. Finding position by bearings. The upper drawing shows the bearings as read from the ship by compass; the lower how these are drawn on the chart to meet at the ship's position.

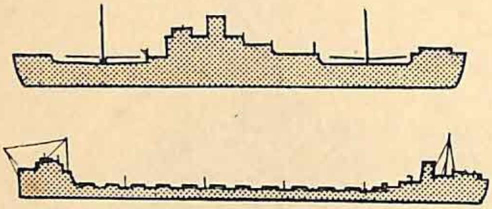


Fig. 74. A passenger-cargo liner and a Great Lakes ore boat. Explain the difference in outline.

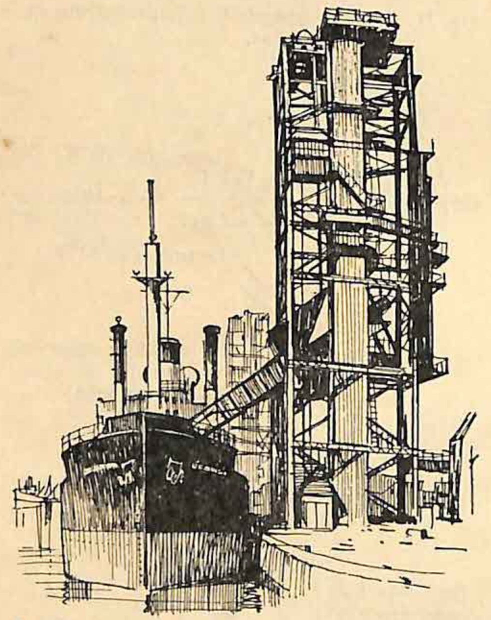


Fig. 75. Coaling ship. Coal wagons are lifted by the hoist and the coal is tipped down the shoot.

IN THE ENGINE ROOM

THE Chief Engineer ranks next to the Master in importance on board ship. For her good working they must be constantly in touch with one another. Quick, safe and profitable voyages depend as much on his care of the engines as on the Master's navigation and knowledge of the sea. He directs men of many trades and keeps account of many stores.

Until about 40 years ago most ships used coal for fuel. To-day most ships burn oil instead of coal. It has many advantages. Ton for ton it gives more heat and the firing can be more quickly and easily controlled so that less steam is wasted. It is easily loaded through great hose-pipes without the noise and dirt of coal loading. Awkward spaces, even the double bottom of the ship, where men could never get to shovel coal, can be used to store it.

The stokehold is now clean and bright and much cooler than in the old days. Instead of the army of sweating stokers a handful of men control the taps and jets through which the oil is sprayed into the furnaces. In another type, the motor ship, there are neither furnaces nor boilers. They are driven by huge diesel engines made on the same general lines as those used on buses and heavy lorries.

On steamships the steam from the boilers passes through the main engines and forces the propeller shaft round. There one can really see the enormous power needed to drive a big ship. The *Queen Mary*'s engines can develop

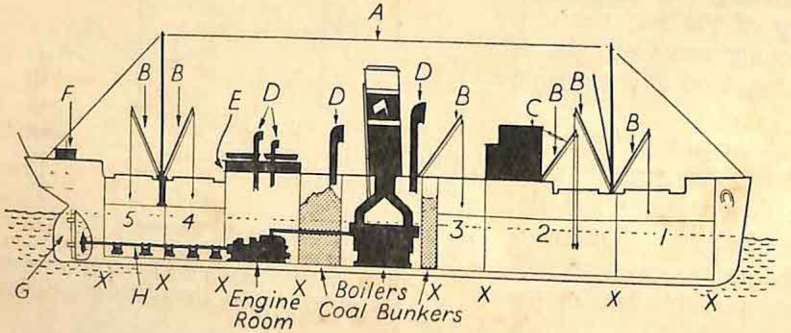


Fig. 76. A cargo boat.
A—aerial.
B—derricks.
C—Bridge.
D—ventilators.
E—quarters.
F—steering machinery.
G—rudder.
H—propeller shaft.
1–5 cargo holds.

no less than 158,000 horse-power. This power is used to drive round the propeller blades whose push against the water forces the ship forward.

The officer on duty on the bridge is in touch with the engineer on duty in the engine room by telegraph and telephone so that orders can be carried out at once. The Chief Engineer, like the Master, is always on duty. He too carries out a daily inspection besides paying frequent visits at other times. He keeps a careful eye on fuel consumption. Though he always starts a voyage with more than enough to carry him through a normal trip he must always be prepared for emergencies, such as going to the help of another ship or stormy weather, causing a longer passage. How important this may be is shown by the fact that though the *Queen Elizabeth* starts each voyage with 8,000 tons of oil on board she uses 1,000 tons each day. Besides knowing how to get the best out of his engines the Chief Engineer must also be able to repair them. He feels disgraced if his ship has to be towed into port, except when he has had a really serious breakdown. He must know almost every branch of engineering, from plumbing to heavy electrical and steam engineering. A sea-going Chief Engineer seldom has any difficulty in finding a shore job if for any reason he gives up the sea.

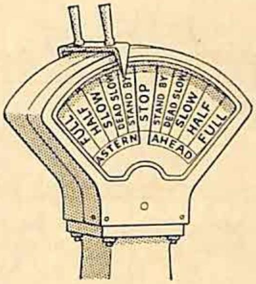


Fig. 77. Engine room telegraph by which the officer on the bridge signals his commands to the engine room.

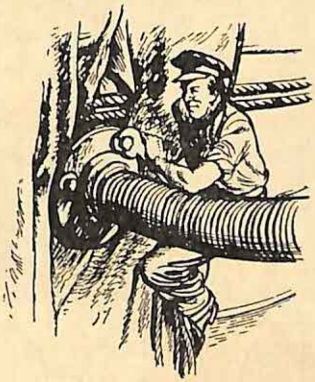


Fig. 78. Oiling ship. Oil is pumped to the ship's fuel tanks through the hose. Compare with Fig. 75.

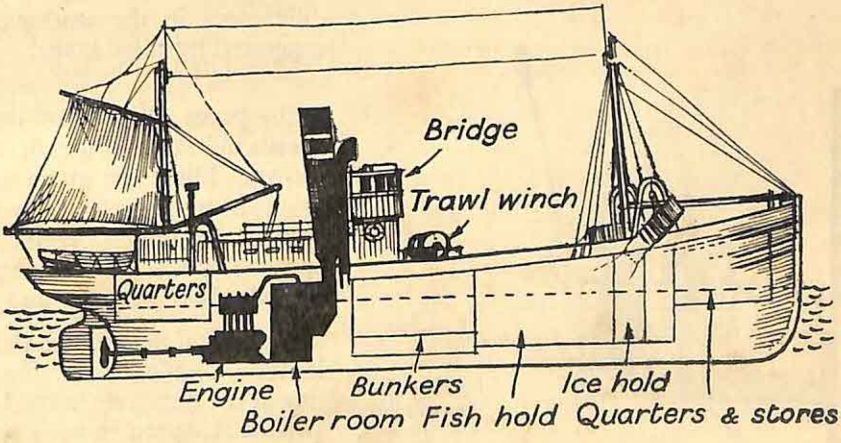


Fig. 79. Lay-out of a North Sea trawler. (Length 120 feet.)

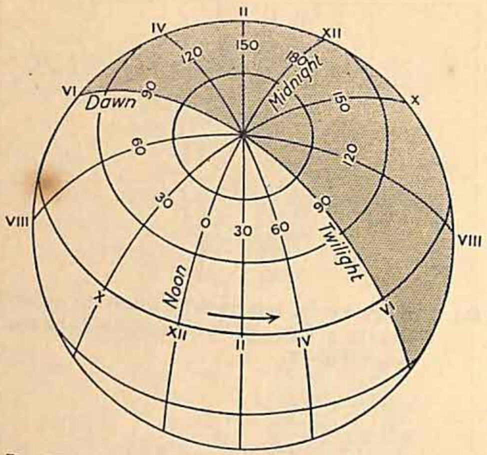


Fig. 80. Longitude and time.

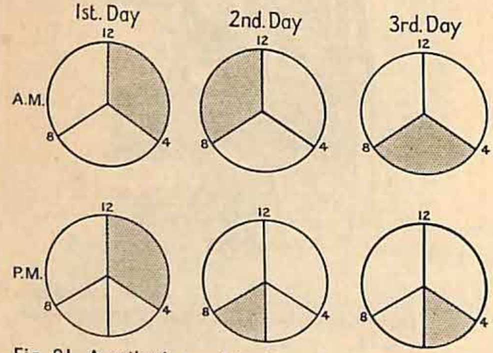


Fig. 81. A sailor's working hours.

Fig. 82. Taking soundings with the lead.

1 A radio commentary on the closing overs of a Test Match in Sydney finishing at 6 p.m. on February 17th was heard in London just before 8 *a.m. the same day*. How was this possible? What can you learn from it about the longitude of Sydney?

At what time and on what day could a person in Sydney hear the opening of the 6 p.m. news bulletin of August 14th from London? (See Fig. 80.)

2 Many radio messages to and from ships at sea are signalled in Morse Code, *i.e.* by dots and dashes instead of letters and words. Why? What are the Morse signals for "SOS"? All ships hearing this call immediately shut down, *i.e.* stop sending messages. Why?

Why is the Master of a ship hearing "SOS" called to the bridge at once?

3 Fig. 81 shows the working hours of a sailor on any three consecutive days. Draw a similar diagram for a worker at a local factory or office (*a*) in midweek, (*b*) at the weekend.

Name any other workers whose hours are in any way similar to those of the sailor.

4 The main part of the Port of London is shown in Fig. 6, of New York in Fig. 83. What differences in the working of the ports are suggested by these maps?

5 On pages 28 and 29 the normal working speeds of some different types of ships are shown. These are given in knots. A ship is said to be making 20 knots when she is travelling at 20 nautical miles per hour. (It is incorrect to speak of knots *per hour* since the term knot includes both distance and time.)

A *nautical mile* is one-sixtieth of a degree of latitude, *i.e.* 6,080 feet. If a motor car is travelling at the same rate as the ship making 20 knots what is its speed in *miles* per hour?

6 How did the sailor in days gone by measure the depth of water beneath his ship? How is this done on a big ship to-day?

7 A ship is steering on a course of 45 degrees. To port there is a lightship at anchor bearing 90° from the ship. Draw a diagram to show the relative position of the two ships. Indicate the direction of north on your sketch.

8 Until late in the eighteenth century navigators could not accurately determine their longitude. Their determinations of latitude were much more accurate. Why?

What new instruments made accurate longitude fixing possible?

9 Stars have long been used by sailors for the finding of position, direction and time. They can only be used on clear nights however. Two groups of stars, the Little Bear and the Great Bear, are useful in finding the Pole Star. From it latitude can easily be found. Fig. 84 shows these stars and Fig. 85 a simple piece of apparatus by which you can find your latitude from the Pole Star.

Can the Pole Star be seen in the Southern Hemisphere?

10 Draw a diagram to show how the sun appears to move across the sky in your district. Mark on it its position at noon.

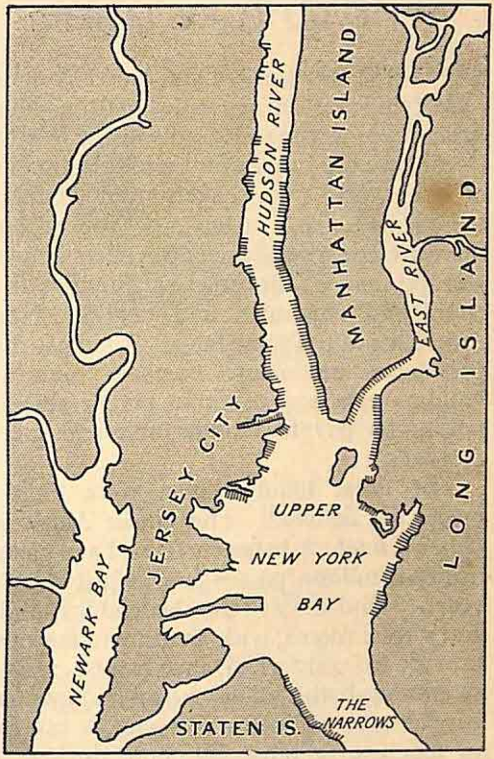


Fig. 83. New York harbour.

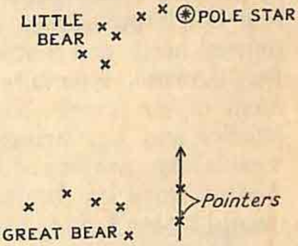


Fig. 84. North polar stars.

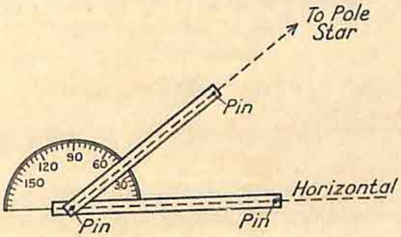


Fig. 85. How to find your latitude.

THE LUXURY LINER

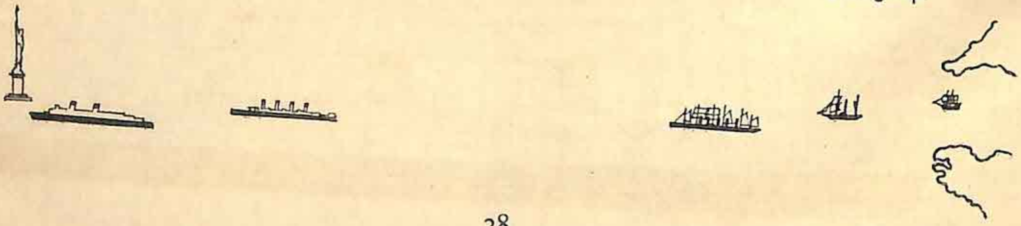
WESTERN Europe and North America, lying on either side of the North Atlantic, or as the sailor calls it, the Western Ocean, are the busiest and wealthiest regions in the world. Passenger traffic between them is larger than on any other route though there are also a good many travellers between Europe and South America, South Africa, India and Australia, and between North America and the same lands. Amongst these passengers are many business men and holiday-makers, prosperous people able and willing to pay for comfortable and speedy passages.

The great luxury liners were built to meet this demand. The *Queen Mary* and *Queen Elizabeth* between them have carried nearly a million passengers in just over six years. Handsomely furnished cabins, dining and public rooms, with an army of stewards, provide for comfort. Dance bands, cinemas, swimming-baths, games rooms and gymnasia supply entertainment. Passengers can keep in touch with office or home through the ship's radio and read of world happenings in the ship's newspaper. Few even of the best hotels provide so fully for their customers' needs and fancies. But speed is the first demand, especially since the development of air travel. The newest ships are smaller and less luxurious than the older vessels but are speedier. Thus the new *United States* has beaten the *Queen Mary*'s record by ten hours.

Passenger liners on the other routes have never been as large as the North Atlantic giants. The Suez and Panama Canals are too narrow for the giants and passengers are both fewer and generally less well-to-do. But even if they are not giants, they provide both comfort and entertainment in abundance, on a less grand scale and at lower speeds. Thus the *Pretoria Castle* on the Cape run and the *Oronsay* to Australia do 22 knots as against the 29 of the *United States* and the 28½ of the *Queens*.

Only frequent and regular passages can make such vessels earn a profit. From the moment they arrive in port until they leave again swarms of men are at work on them loading stores of all kinds and making minor repairs or adjustments. Fuel by the thousand tons, food by the trainload, clean linen for cabins and dining-rooms, drinks for the bars, crates of crockery to replace breakages (which may have been heavy if the passage was stormy), and stores for the engineers, have all been got ready before the ship docks. All these must be got on board, and cargo and used materials unloaded, perhaps in twenty-four hours. On each of the *Queens* there may be 2,000 passengers and will be a crew of 1,000 to feed for four days. Passenger lists and loading documents for cargo must be handed over and everything checked. All cabins and rooms get an extra clean in readiness for their next occupants. And whilst these are being completed, fast trains are on their way to the port bringing passengers' luggage and then mails and finally

Fig. 86. Four days out from Southampton. The ships are those in Fig. 88, except the Viking longship.



the passengers themselves. All is hurry and bustle, but it is an orderly bustle, until at last the tugs come alongside, ropes are cast off and the liner heads once more for the open sea, on the day and the hour advertised for the sailing perhaps months before.

All are glad when they can settle down to the regular sea routine again, except perhaps those who have been able to get ashore for a few days or hours on leave. The Purser and the Chief Steward are especially glad, for they and their helpers have had perhaps the most anxious time, making sure that all supplies are on board, all documents from the previous voyage duly handed in and those for the new passage completed and received. The stewards have seen each passenger to his proper cabin and his place in the dining-room has been settled.

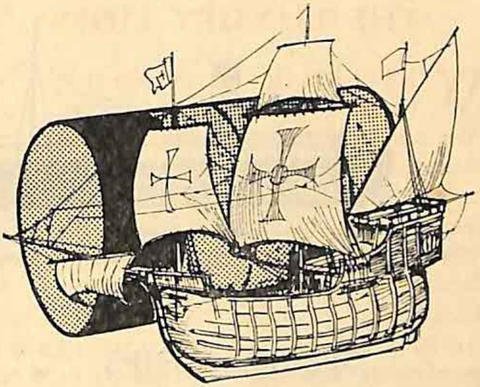


Fig. 87. Columbus' ship, the *Santa Maria*, compared with a funnel of the *Queen Elizabeth*.

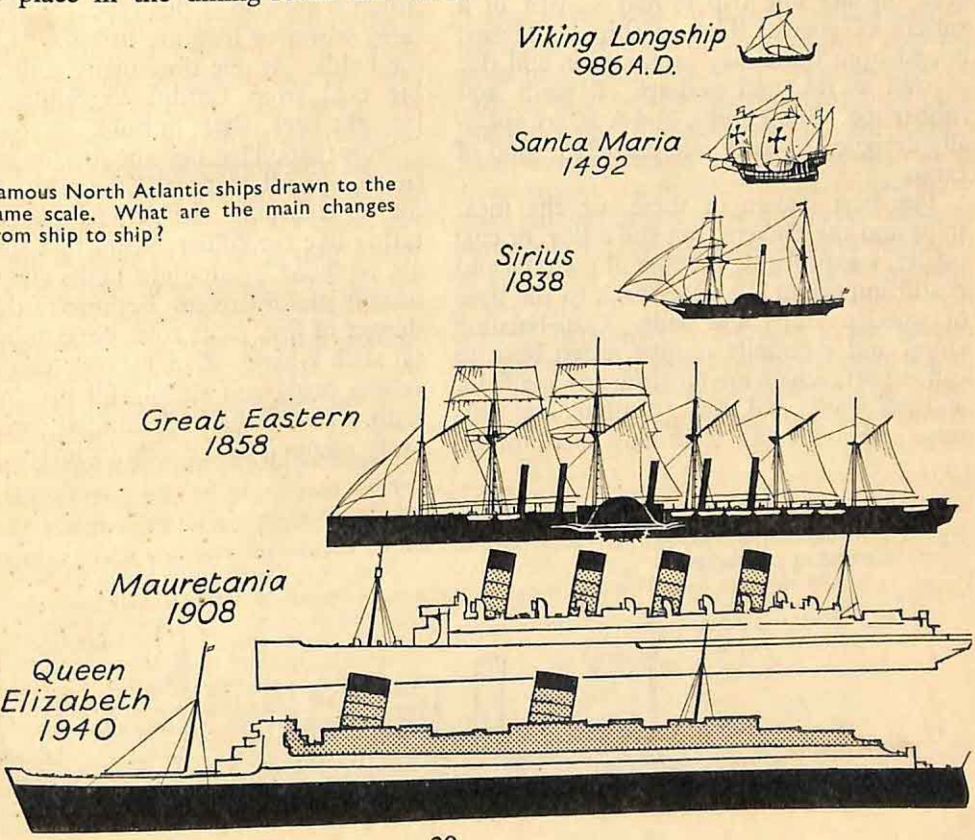


Fig. 88. Famous North Atlantic ships drawn to the same scale. What are the main changes from ship to ship?

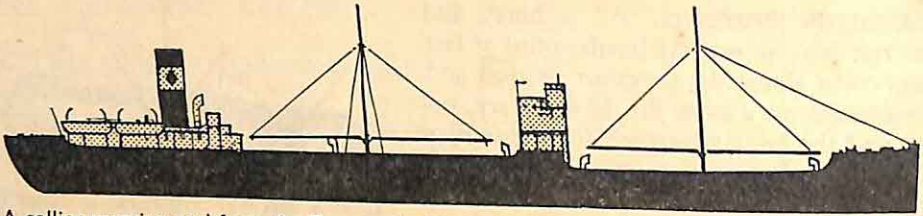


Fig. 89. A collier carrying coal from the Tyne to the Thames. Deck structures are kept low and masts, which only carry the aerial, can be lowered when passing under river bridges.

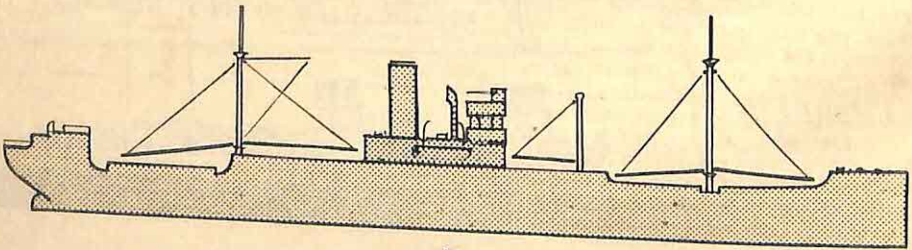
SPECIAL SHIPS

MANY cargo liners and all tramp ships are fitted to carry general cargo. Their load on any particular trip may be quite different from that on the last, and even on any one trip it may consist of a variety of goods. Thus a ship homeward bound from India may carry cotton and rice as well as tea, and perhaps oil seeds and rubber too. Some ships, however, are specially designed to carry one particular kind of cargo.

The best known of these are the meat ships and the tankers, but the *collier*, or coal carrier, was probably the first of the type and is still important. It dates back to the time of wooden ships and sails. Coal-burning ships, and especially tramps, often have to call at ports which are far from any coalfield, and gas works and power stations and railways are built far from any coal mines. To-day the main task of the collier is to carry coal to such places. They, and the ore-carrying boats like them, have their funnels, engines and crew's quarters aft, so that loading and unloading are made easier. The "whalebacks" on the Great Lakes of North America are also of this type. Some of these carry wheat or iron ore in bulk, *i.e.* loose in the holds. At one time many colliers carrying coal from Cardiff to South America brought back wheat in bulk.

Now that oil has become such an important cargo, special ships called *tankers* are used for its transport. In general plan they are rather like the collier except that their holds are replaced by air-tight tanks and they are usually motor driven. Because of the special danger of fire, strict rules have to be obeyed on such vessels. Usually they can carry no return cargo and simply fill up their tanks with water as ballast. Similar vessels now carry palm oil to the soap factories, molasses

Fig. 90. A timber-carrier. Superstructures are high to allow for deck cargo. Masts are strong to carry derricks for loading in small ports.



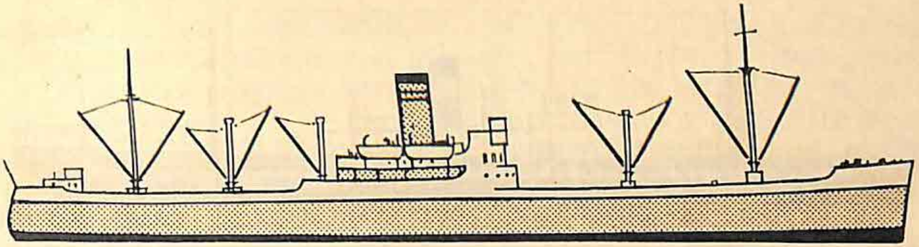


Fig. 91. A refrigerator ship. Her lines show that she is built for speedy voyages and her deck structure provides space for a few passengers.

to the sugar refineries and latex to the rubber works.

Another special type is the *timber-carrier*. Her sunken or well deck is kept clear to make room for a deck cargo of logs over the sawn deals in the holds. Many of these ships sail from Hull and Leith to Finland and Scandinavia to collect timber cut in their vast forests.

Other special types include the deep-sea trawler which makes month-long trips to the cold northern seas in search of cod, halibut and haddock; the ocean-going tug and salvage vessels, with their powerful engines, always ready to go to the help of disabled ships and tow them into port; and the cable ship which lays and repairs the telegraph and telephone cables laid on the ocean bed.

The aristocrats of the special class are the *refrigerator ships*. These are cargo liners which have holds that can be kept cold enough to preserve foodstuffs even on long voyages through the tropics. The meat ships which bring thousands of carcases of beef and mutton from Australia, New Zealand and South America are of this type and so are those bringing butter and cheese. So too are the fruit carriers which sail between the West Indies and Bristol with their holds packed with bananas. In these ships the temperatures are gradually raised as the home port is approached so that the fruit, loaded green, is at the right stage of ripening when landed. The chief engineer's staff on these boats always includes a group responsible for the refrigerating machinery and for checking the temperatures in the holds. Their cargo needs as careful watching as a fever patient in a hospital. Many of the fruit boats are beautiful craft and carry passengers, not numerous enough for them to be classed as liners but more than the twelve allowed in any ship.

Many passenger liners such as the South African and Australian mailboats have some refrigerated space and can carry fruit or dairy produce on their homeward voyages.

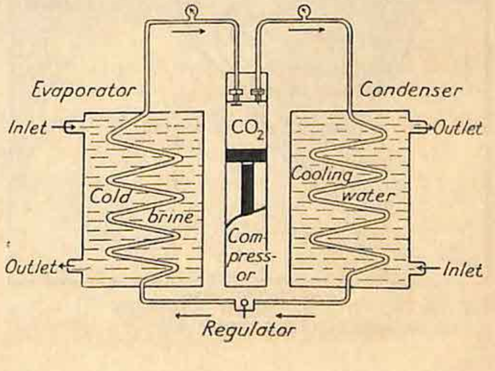


Fig. 92. Diagram of refrigeration plant. You can learn from your cycle inflator how it works. When you blow up a tyre the air is compressed in the inflator and warmed, so the barrel becomes warm. The jet of air expands as it escapes and you can feel how this cools it. Here the gas is compressed in the central cylinder and cooled as it passes through the pipe in the right hand cylinder. The regulator allows it to expand in the evaporator so that it cools the brine. This is carried round the storage hold in pipes.

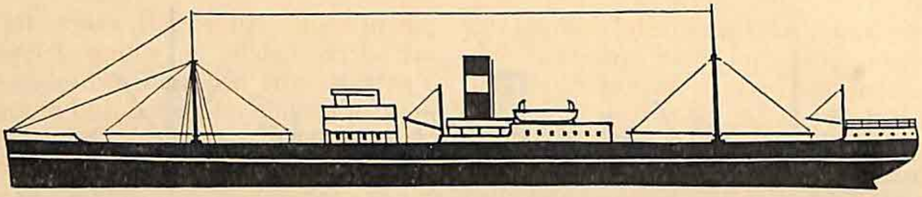


Fig. 93. The S.S. *Macduff*, a coal-burning cargo vessel of 6,000 tons with a speed of 11 knots. The long derricks show she has big hatches over her holds and so can carry bulky cargo such as rails and girders or machinery, if necessary.

Can you see anything in the drawing to suggest she is (*a*) a coal burner rather than an oil burner; (*b*) a steamship rather than a motor ship; (*c*) a tramp steamer rather than a cargo liner; (*d*) an ocean-going rather than a sea-going ship?

A TRIP IN A TRAMP

As the captain of a tramp ship, John Thomson's father was often away from home for many weeks, sometimes for several months. At these times both John and his mother watched eagerly for the postman to call. The lad's collection of foreign stamps was the envy of all his schoolmates, but even better than having a new stamp to add to it he liked to have a letter of his very own. Here is one written to him from New York.

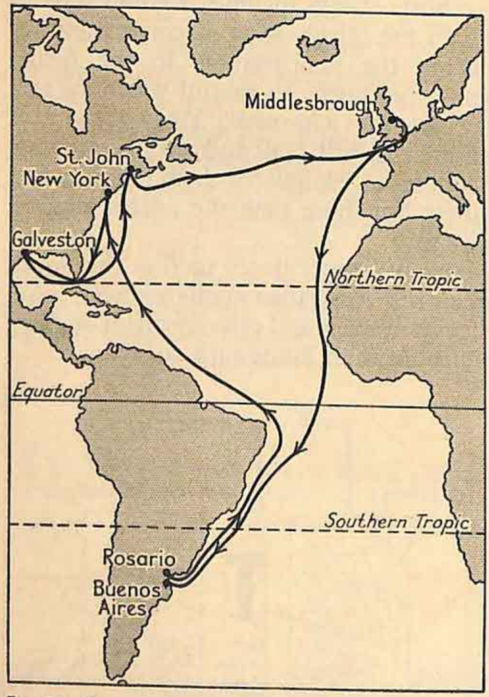


Fig. 94. Map of the *Macduff*'s voyages. This is a typical run for a tramp ship.

S.S. *Macduff*
July 22nd

Dear John,

The last time I wrote to you was just when we were leaving Middlesbrough for Buenos Aires. We had loaded a lot of stuff for one of the Argentine railways—steel trucks and rails, girders and plates for bridge building and bags of bolts and nuts and rivets. A fine clatter that cargo would have made if it had come adrift in a heavy sea. But my new first officer had made a good job of stowing it and anyway we never had a heavy sea, even crossing the Bay of Biscay. We had a quiet trip and made good time.

After unloading at Buenos Aires we were ordered up river to Rosario to pick up a cargo of linseed for New York, where we now are. The journey up-river was not a pleasant one. We had a river pilot of course but the channel was narrow and twisty. The muddy waters made it difficult to see the sandbanks and there was little else to see. The river wanders about between two high banks and we could see nothing beyond them. It is dead flat farm land anyway. A strong wind behind us covered everything on board with dust. We were glad to get back to Buenos Aires and head for the open sea.

The trip up here has been just as rough as the outward run was peaceful. We had several blistering hot days as we worked up to the line and across it. Then, as I expected, we ran into heavy weather off the West Indies, a real tropical storm. We often get them at this time of year in those latitudes. As the ship drove on into the wind for hours it seemed to hold us back as though we were pushing against a solid wall. Great seas came rushing at us, waves 20 feet high and more that seemed as if they would swamp us any minute. But the *Macduff* staggered up to their crests and then plunged down into the following troughs. She is a stout ship, a credit to the good men who built her. There wasn't a dry spot aboard her when we left the storm behind, but we had suffered no damage that the carpenter could not put right in a few hours.

The storm left a nasty swell behind and the *Macduff* groaned and creaked as we steamed northward. But after thirty hours on the bridge it would take more than that to keep me awake. A few hours' sleep and the first hot meal for a couple of days soon put us right. All, that is, except for one of the deck hands, a young fellow from Tyneside, who had an arm broken when a wave swept him off his feet and brought him crashing down on the deck. I fixed it up for him until we made port and now the hospital folk are seeing to it.

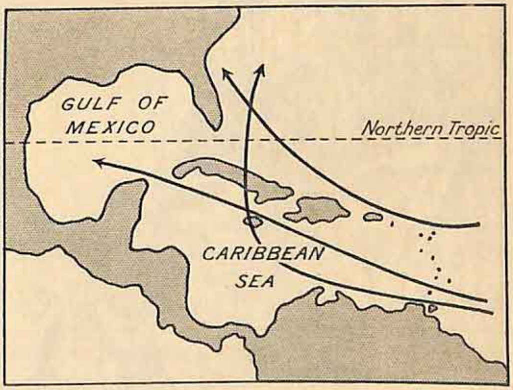
We have just discharged our cargo here. The crew expected we would be loading with wheat from Canada for a run home but I am afraid they will be disappointed. We are too early for the grain. The company's agent told me this morning he thinks he will have a job for us in a day or two—a run down to Galveston to load with sulphur for the Canadian paper-mills. We ought to be back to St. John, New Brunswick, in time for a cargo home, which he is trying to fix for us—mainly tinned fish, I expect, and wood pulp. We shall have to sail to Galveston in ballast so I hope we shall not run into another hurricane; one is quite enough for a while.

I hope you are having a good holiday. I'm afraid it will be over before I get home. Tell Mother she can expect me about the first week of September.

Yours,
The Skipper.

Fig. 95. Tracks of West Indian hurricanes. These great wind storms usually follow a period of hot calm weather. They begin near the equator and sweep north-west across the islands. The ship's barometer gives warning of their approach, and radio warnings of their whereabouts and probable movements are sent out from weather stations.

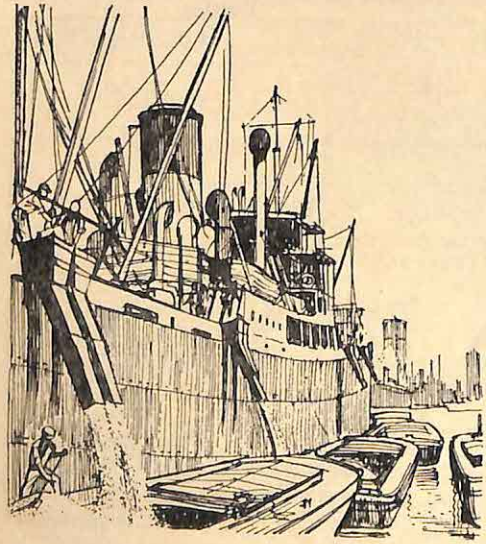
A well-built ship has little need to fear hurricanes if she is far out to sea, but they can be very dangerous if she is near the island coasts with their coral reefs. They do great damage along the shores where they drive in great billows, often wrongly called "tidal waves". These wreck many small craft and may destroy piers and jetties around the smaller harbours. Inland, banana plantations and even dwellings are often completely flattened by the fierce wind.



HARBOURS

ABOUT two hundred years ago the size of ships began to increase rapidly. This was because of the great growth in ocean trading. Cargoes of tea took more room than the silks and spices of earlier days. Cheap materials such as raw cotton and timber were profitable to carry only in large quantities at a time. When steam came into use and railways were being built in the Americas, only big ships could take the engines, machinery and railway materials sent out from Britain.

This change in the size of ships brought great changes in the ports and harbours used. Many of the old ports lost their trade because they were too small. Some of them grew rapidly because they took over the trade of the smaller places as well as increasing their own trade. Some quite new ports were built. Ships went, of course, to the places where profitable cargoes could be obtained. Thus big ports grew up near the new wool-producing lands in Australia, the grain and cattle lands of South America, the cotton plantations of North America and the coalfields and factory towns of Britain.



The small ships of Elizabethan and earlier times could be run ashore on a sandy beach without suffering much damage, provided the weather was good or the beach sheltered. This was often done when the hulls needed cleaning, tarring or repairing. It was sometimes done for cargo loading, for carts could, at low tide, bring goods alongside. More generally, however, the ship anchored where the water was deep enough to keep her afloat and her cargoes were handled by rowing boats. What was needed for ships in those days was a sheltered and roomy harbour. There the ships could furl their sails and anchor without fear of being driven ashore by a sudden storm. There too the water would be calm enough for the small boats, deeply laden with goods, to pass freely between ship and shore.

Deep rivers with long estuaries were very suitable, especially if they had strong tides. When the tide was rising it would carry the ships in from the sea and when it ebbed it bore them out. The tides thus did the work of the modern tugboats, moving the ships in waters too narrow for them to use their sails easily. London and Bristol were amongst the many ports helped in this way. Long arms of the sea, such as the Scottish lochs and the Norwegian fiords, or narrow water passages between islands and the mainland were also useful harbours because their waters were sheltered from heavy storms. The port of Durban in South Africa has a wide stretch of water sheltered by the high bluff and a narrow entrance. New York harbour is near the mouth of the deep Hudson River and is sheltered by the islands at its mouth. Sydney in New South Wales stands on the shores of Port Jackson, a long, deep branching inlet which forms perhaps the finest harbour in the world. Look at the plans of the harbours in Figs. 83, 98, 99.

Fig. 96. Unloading grain into lighters in a London dock for transfer to riverside mills.

The quality of the harbour still, even to-day, settles the character of the ships which use it. The largest cargo liners cannot trade to Baltic ports because the harbours are too shallow for them to enter. Giant passenger liners cannot pass through the Suez Canal for the same reason. Broad, rather flat-hulled ships are slow and roll a good deal in rough seas, but because of their shallow draught they can pass over the shallow waters at the bar of a river and pass far inland where the speedier but deeper-draught ships cannot go. Tramp ships, because of their usually rather small size, visit the lesser harbours that have not room enough for cargo liners to anchor.

A good harbour will have a deep and safe entrance from the sea, easily followed in bad weather and not obstructed by sandbanks, rocks or ice. It will have plenty of room for ships to anchor when loading or unloading and with good protection against storms. A long waterfront, that is a good stretch of shore convenient for landing and taking on cargo, is of great value because it enables many ships to be dealt with at the same time. New York and Southampton are good examples of ports which are favoured in this respect.

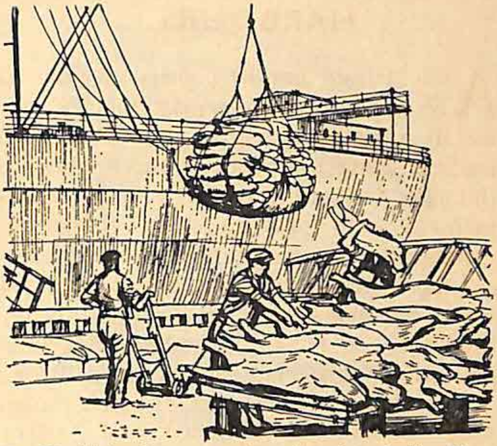


Fig. 97. Unloading meat in a London dock. The carcases are taken at once from the refrigerated hold to the cold store on the dockside.

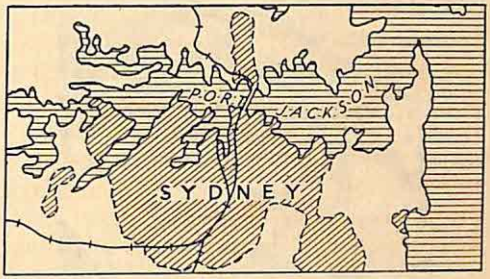


Fig. 98. Sydney harbour.

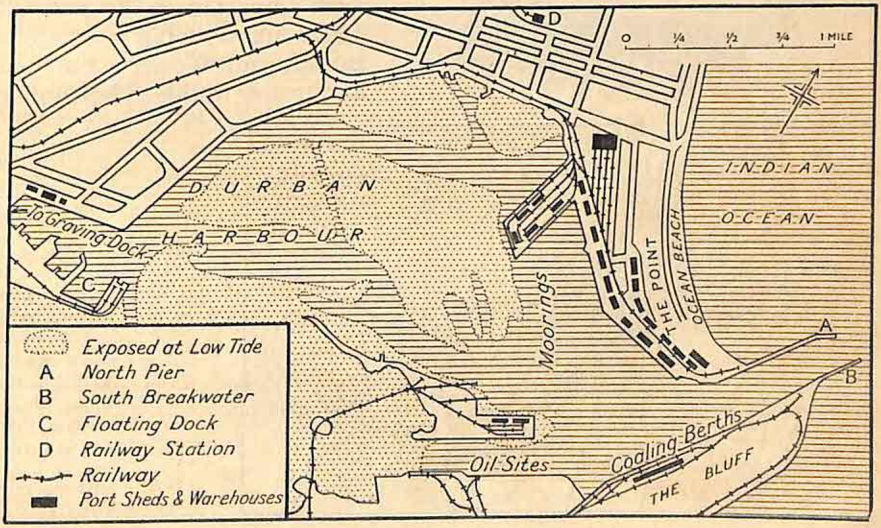
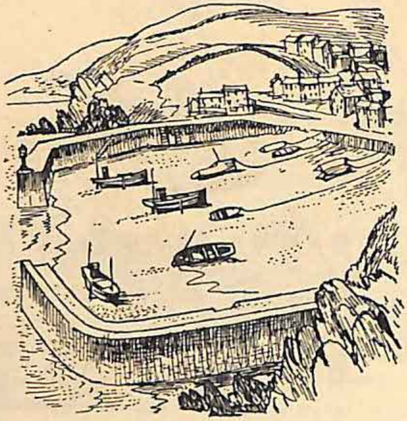
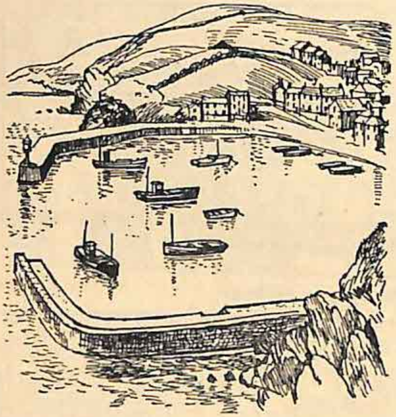


Fig. 99. Durban harbour. Pick out the provision for landing passengers, storing and transporting goods, repairing and fuelling ships, keeping out storms and drifting sand.



Figs. 100 and 101. A small fishing port at low tide and high tide.



PORTS

THE Romans used the word *porta* when they spoke of the gate of a city. Hence comes our word *port*, for its ports are the gates of a country. Through them pass, to and fro, all the goods and passengers entering or leaving the country by sea. Not every coastal town, however, has or will become a port, nor will every good harbour have an important port on its shores. Three things are necessary to the growth of a port. They are: a good harbour, a productive area to supply cargoes, and easy means of getting the cargoes to and from the ships in the port.

This may be provided by wharves where ships can tie up alongside in deep water, or by piers built out from the shore to serve the same purpose. Thus though New York has miles of shore line it has also scores of piers or jetties. Other ports, such as London and Hamburg, have provided loading and unloading space by making docks where this work can be carried on.

The land area served by a port is called its *hinterland*. The more goods—whether food, raw materials or manufactures—it produces for export or requires as imports, the larger and more important is its port likely to become. There are more big ports around the shores of Britain and Western Europe than anywhere else in the world. They are needed to unload

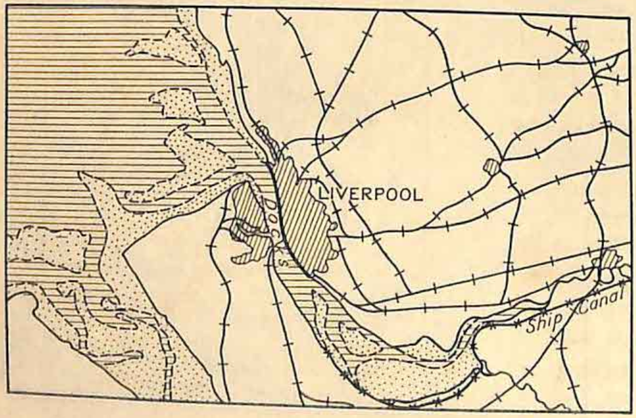


Fig. 102. The port of Liverpool. The docks are at the mouth of the estuary where the strong tide keeps the channel clear.

Three channels lead from the open sea to Liverpool docks. Which is most likely to be used by big ships? Why?

How does the map help to explain why a great port has grown up on the Mersey estuary rather than on that of the Dee?

the shiploads of meat and wheat to feed their people, of raw cotton and wool and ores for their factories, and to carry away the manufactured goods they send in payment for these things.

All the goods have to be distributed to the parts of the hinterland which need them or collected from the areas making or growing them. This may be done by rail, road, river or canal. Almost any map of England will show how many of its main railways and roads run into London. The navigable River Rhine helps the trade of Rotterdam in the same way. The construction of such means of transport is much more difficult in hilly or mountainous country than across a lowland. This is one reason why such magnificent natural harbours as Milford Haven or the Norwegian fiords have no large ports.

On the other hand wealthy hinterlands make it worth while to build artificial harbours or improve very poor natural harbours. Thus shallow river mouths have been deepened by dredging so that ships can enter them. Great stone and concrete piers are built out to sea to form sheltered anchorages on open coasts. This was done at Takoradi on the Gold Coast of West Africa, where since the slaving days both passengers and goods have been carried between shore and ship, through the surf, in small boats. The low muddy shores of many estuaries, such as those of the Thames and the Humber, have been excavated to provide docking room. Low ground along the water front is always a great advantage because it makes simpler the laying of railway tracks right up to the loading wharves and provides sites for the construction of warehouses and stores close by the ships.

As the journey up a crowded estuary is bound to be slow and passengers are always in a hurry, some estuarine ports have *outports*. These are smaller ports near the open sea where passengers and mails can be landed to go forward by rail. Some of the Channel ports act in this way for London, and Rotterdam and Hamburg are similarly served.

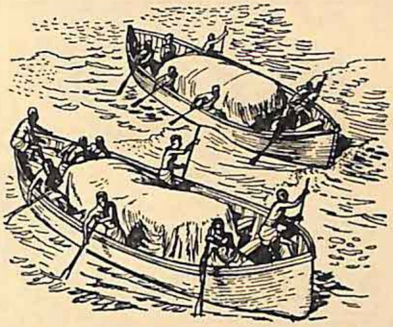


Fig. 103. Surf boats carrying cocoa from beach to ship off the West African coast.

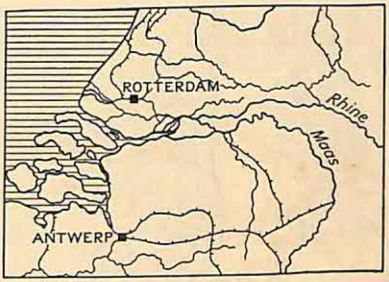


Fig. 104. The Rhine delta waterways. Why does Rotterdam handle more German goods than Antwerp?
Rotterdam has an outport, Antwerp has not. Can you see from the map any reason for the difference?

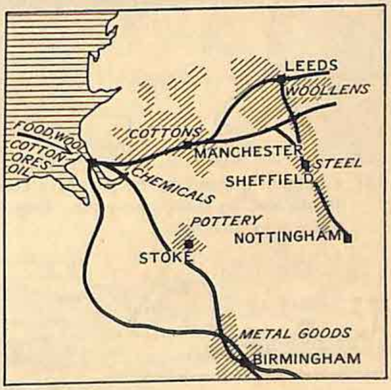


Fig. 105. Liverpool's hinterland. What goods is it likely to export?
Many goods arrive by road. Why?

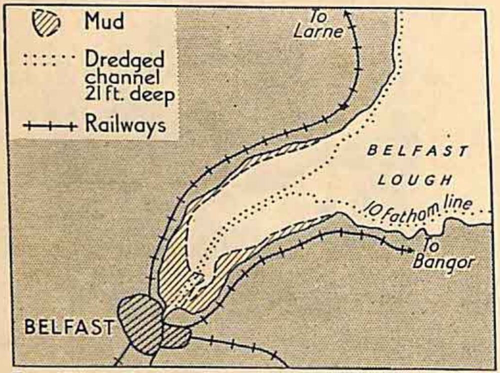


Fig. 106. Belfast—a long dredged channel is necessary.

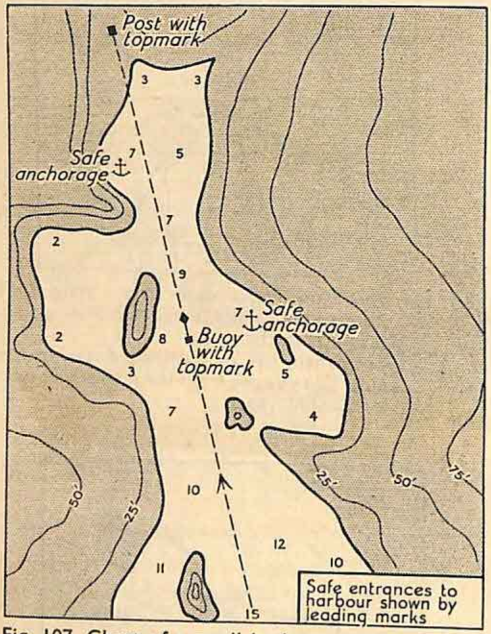


Fig. 107. Chart of a small harbour, entry to which is marked by buoy and post. Depths are shown in fathoms.

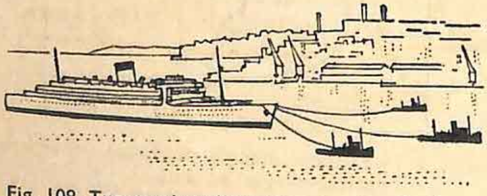


Fig. 108. Tugs towing a liner into a spacious harbour.

ENTERING PORT

THE movements of a ship at sea are constantly reported. Her owners can thus tell within a few hours just when she will reach a particular port and on what tide she will probably enter. Her Master will adjust her speed so that she arrives off the port some time before high tide. Just how long before will often depend on her draught, *i.e.* the depth of water she needs for safe working, and on the depth of the channel. He will try to arrive so that the tide is still rising as his ship moves to her berth.

Even before she enters the harbour she will come under the control of many rules and regulations necessary for her own safety and that of other vessels in the harbour. Her owners or their local agent will have made sure already that a berth in dock or alongside a quay is reserved for her. But as a rule she cannot proceed straight to it. She must in most cases be under the care of a local pilot. He may have been put on board from a pilot cutter whilst still some miles out to sea. He knows the harbour and its entrance channels as well as a boy knows his way home from school. Every buoy, light, bearing and mark, the ways of local currents at all states of the tide, the depth of water and the position of all shoals—all these things he knows perfectly. Though the Master is still responsible for the ship and the pilot is simply his adviser, it is the latter, standing by his side on the bridge, who gives orders to the officer at the engine-room telegraph and the man at the wheel.

Soon one or more tugs appear and escort the ship until their help is needed. Then the heavy towing hawsers are passed on board and made fast. The ship still moves under her own engines and with the help of the tide. The tugs do not really tow her but rather check her speed or pull her head round to keep her in the deep channel and clear of other craft.

On her way into port the Port Medical Officer and the Customs officers will come aboard. The former will receive a report from the ship's doctor and, if necessary, see men reported sick in case they may be suffering from plague or smallpox or other serious infectious disease. He can order the ship into quarantine, *i.e.* to be isolated, the sick removed to hospital and everyone else kept on board until the vessel has been fumigated and the danger removed. The Customs officers make sure that no smuggled goods are on board and examine her documents showing the cargo carried. The Purser or the Chief Officer will deal with these. The ship's *manifest* gives details of every package carried.

As she proceeds the ship is watched by the Harbour Master's staff. Unlike a motor car a ship has no brakes and so cannot stop or turn quickly. She therefore signals all her movements before she makes them and the harbour staff will warn her if such moves are dangerous. As she reaches the dock entrance the great gates are opened and ropes are passed to the dock side from her winches. With the aid of these and the pushing and pulling of her tugs she slowly moves to her berth. As soon as she is tied up passengers go ashore, the hatches are opened and the dockers get to work. The Master hurries off to report to the company's office, having handed over control to his Chief Officer. At the office he will see the Marine Superintendent and discuss the trip, giving him an account of fuel consumption and reporting any damage needing attention. He will talk over the work of his officers and hear of any changes in his staff for the next trip. Arrangements will already have been made for those who are to go on leave and for the paying off of his crew. In the old days a new crew was engaged at the beginning of each voyage, but nowadays these are so regular that crews tend to remain with a ship for many trips. Though for a time the ship will be in the hands of landsmen, tied fast to the quay and with most of her fires out, already her next cargo will be arriving, and the arrangements for her departure will be nearly complete.

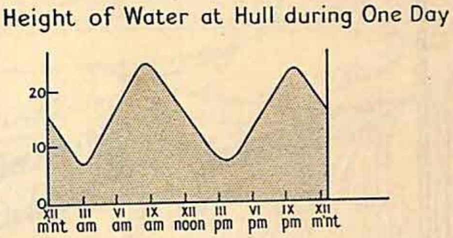
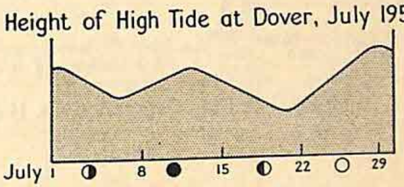


Fig. 109. How the depth of water varies during 24 hours at Hull—note the times of high and low water.
How the height of *high water* varied during a month at Dover—note the three periods of spring tides (near new and full moon) and two of neap tides (near 1st and 3rd quarters).



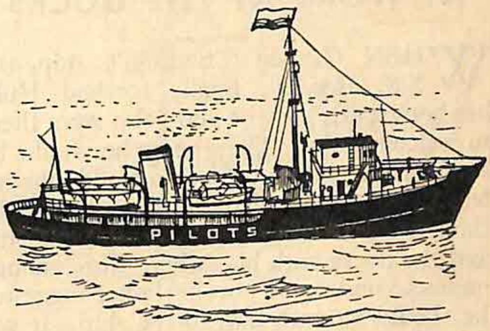


Fig. 110. The pilot cutter waits outside the port.

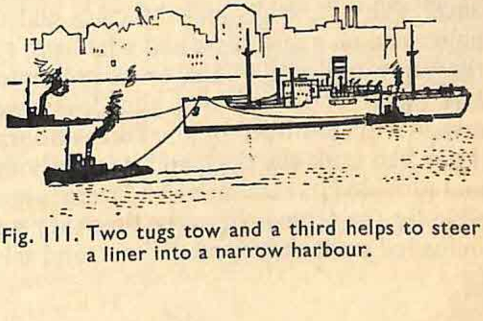


Fig. 111. Two tugs tow and a third helps to steer a liner into a narrow harbour.

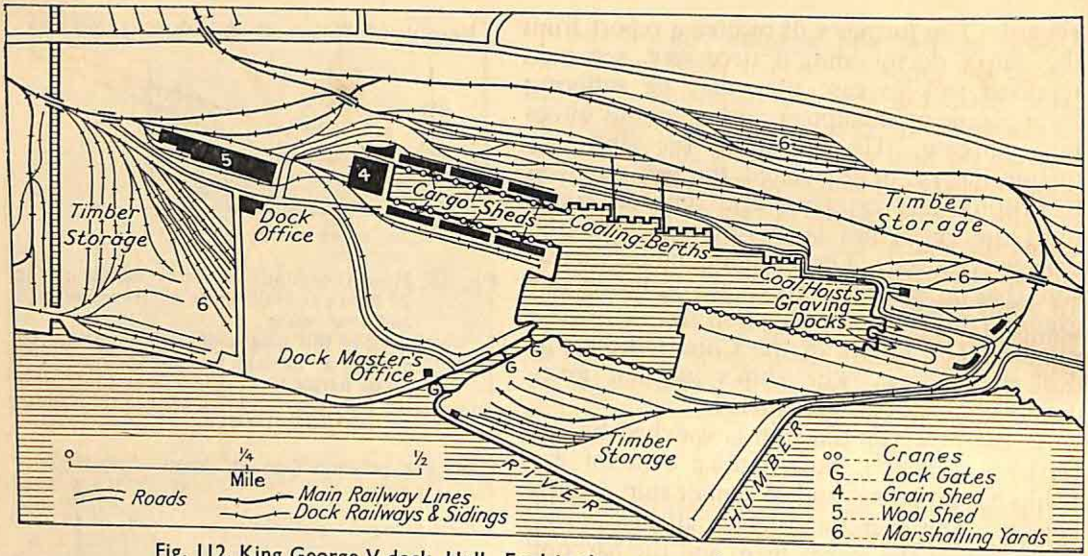


Fig. 112. King George V dock, Hull. Explain the purpose of each named feature.

AT WORK IN THE DOCKS

WHEN Captain Thomson's ship, the S.S. *Macduff*, finally reached Hull, her home port, his wife and John were there to welcome him. They knew he would be kept for a few days before he could take his leave. John was glad of this because he thought he would be able to visit the ship and the docks with his father. Sure enough on his second day in port his father suggested he should go with him to the ship. It was John's first visit to a dock and he had many questions to ask when they had passed through the gates. He started with them at once. Why the walls and the gates and the policeman on guard there and why hadn't he the same uniform as the town policemen? His father explained that the docks were owned and controlled by the Port Authority. They had built the dock and its warehouses and provided its machinery and were responsible for the cargoes from the time they were unloaded until they were claimed and taken away by their owners. Hence the walls and gates and policemen.

John's father took him along the dockside to see how and why the dock had been built. John found that it was a sort of oblong pond enclosed by strong stone walls except for a narrow gap by which ships entered and left. When they reached this gap he saw that it was closed by heavy steel and timber gates. John's father asked him if he noticed any difference between the water in the dock and that in the river. He had not until the question was asked, but then he saw that the water-level in the dock was several feet higher than in the river. It was kept in the dock by the gates. His father told him that was just what a dock was for. The gates were opened for ships to enter and to leave for only a few hours, from just before until just after high tide. If they were left open the water in the dock would flow away as the tide fell and the ships in it would be no longer afloat.

As they walked back along the quay they saw the dock workers busy about their tasks.

Down in the ship's holds the stevedores loaded the cargo on wooden platforms or into large nets. On the deck one man signalled to the watching crane driver when he could haul up the load whilst another checked off the goods raised each time—so many boxes of fruit or bales of wool or sides of beef. The craneman raised the load and swung it out over the ship's side and then lowered it to another team of men. In some cases these were waiting in barges alongside the ship. The Captain explained how the dockers worked in gangs of seventeen men, each gang working on its own as a separate unit. Since ships have many hatches, sometimes as many as a dozen gangs were busy at the same time loading or discharging cargo.

The goods loaded into barges are taken along the river or canal to warehouses or works on their banks. Other goods are packed into lorries or railway trucks standing on the quay. Meat cargoes go at once into cold storage warehouses where they are kept until sent to market. Grain is often unloaded by suction up great pipes into silos or elevators. Oil tankers unload at special places away from other ships and cargoes.

John's father was more interested in the loading. As a junior officer he had supervised that task many times and knew the problems that often arose. How the heavy goods had to be put at the bottom and how stuff to be unloaded at the first port of call must not be buried by that for a later port. He explained too how, above all, everything must be stowed tightly and even wedged so that it would not shift when the ship pitched and rolled in a storm.

Whilst they drank a cup of cocoa in the "Skipper's" cabin on the *Macduff* John began to understand the importance of the docker's work. "You've got to remember, my lad," the Skipper said, "that ships in dock are earning nothing. So the sooner the dockside men get to work and the faster they work the better the owners like it."

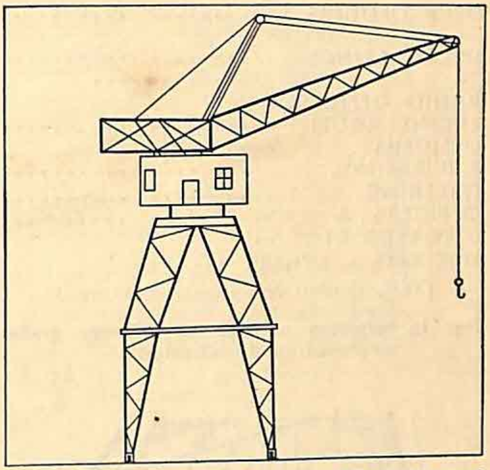


Fig. 113. A mobile crane on a quay. Why is it raised so high?

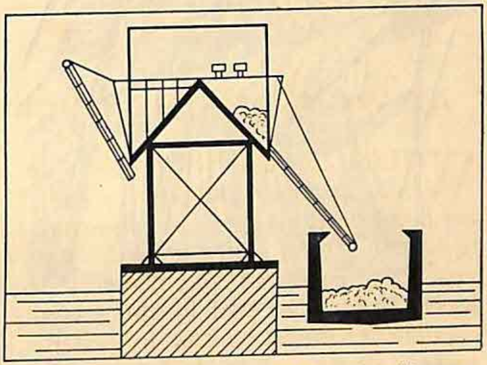


Fig. 114. Loading bulk cargo from truck and hopper.

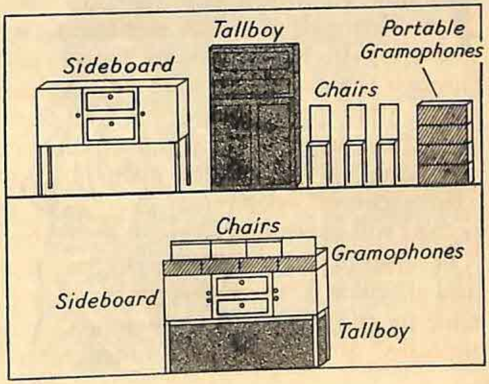


Fig. 115. Skilful stowing saves space. Crates, bales and machines are just as awkward as furniture.

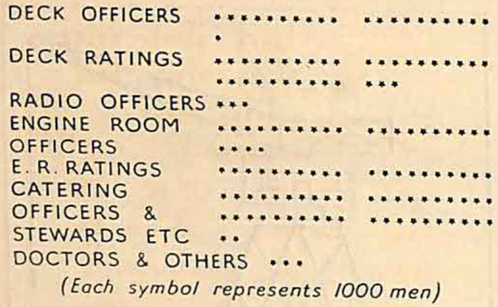


Fig. 116. Numbers of men of different grades employed on British ships.

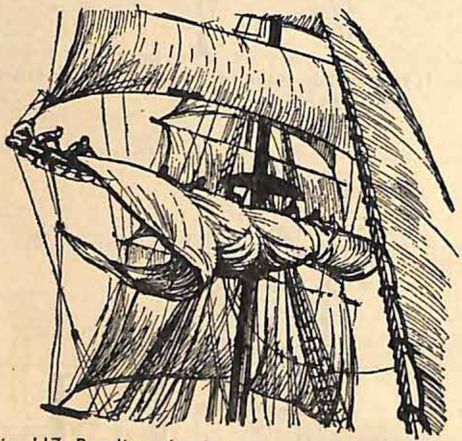


Fig. 117. Bending the foresail in a stiff breeze.

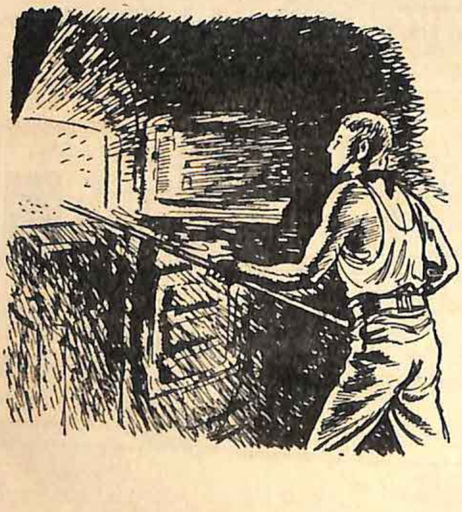


Fig. 118. Stoker "cleaning fires" on a coal-burner.

1 Fig. 116 shows the number of men employed on British ships at sea at the end of 1952.

Which of the groups listed were (*a*) much larger, (*b*) entirely absent, (*c*) much smaller, in the days of sailing ships?

The biggest group amongst the ratings (*i.e.* crew) do nothing in the handling of the ship or in its propulsion. What is their work? In which ships are they most numerous?

There are now more engine room officers than engine room ratings. Fifty years ago the reverse was true. What has caused this change?

The figures include men working on *all* types of vessel, large and small. Which of the following types would have more deck-hands than engine room ratings and which less: a trawler, a tanker, a fruit carrier?

2 How does Fig. 117 help to explain why sailors came to be spoken of as "hands"?

3 The numbers given in Fig. 119 refer only to men employed in loading and discharging cargo, *i.e.* porters, trimmers and stevedores. What is the special work of these groups?

What other important groups of workers are employed on the docks?

4 Describe an imaginary trip in a tramp steamer from the Tyne to the Pacific coast of South America, returning by New Orleans and the West Indies to Manchester, suggesting the cargoes likely to be carried, picked up or unloaded at the various ports of call.

5 Draw simple maps to show what you think are the limits of the hinterlands of (*a*) Sydney, N.S.W., (*b*) New York, (*c*) Durban.

6 Look at Fig. 112. What work goes on in (*a*) a marshalling yard, (*b*) a timber storage area, near a modern dock? Why have they many railway tracks?

7 Here are some jobs in a ship: purser, engineer, steward, ship's carpenter, navigator, wireless officer. Which of these jobs is suitable for (*a*) a grammar school boy good at mathematics and science; (*b*) a boy who is good at writing and figures; (*c*) a boy who is handy with tools; (*d*) a boy who likes tinkering about with machinery; and (*e*) a boy who is smart but not very good at lessons?

8 Cargo liners run regularly between Liverpool and (*a*) ports 1,000 miles up the Amazon River, (*b*) Montreal in Canada. How would you expect these ships to differ in (*a*) their design and equipment; (*b*) the cargoes carried in each direction?

9 Why do ships carry ballast when they have no cargo?

Why do tankers make so many voyages "in ballast"?

10 The two main types of fishing craft are the trawler and the drifter. How and why do they differ?

Fishing craft from Great Britain employ 37,000 hands regularly and 5,000 more at certain seasons. When are most of the latter employed and on what kinds of fishing?

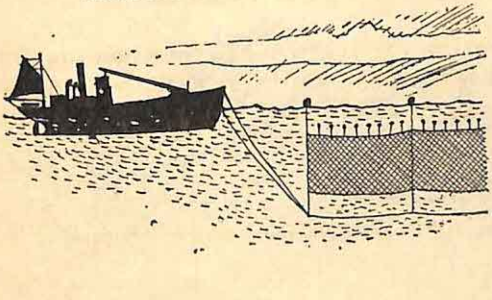


Fig. 121. A herring drifter with her nets down. Her engines are stopped and she drifts with the tide. The sail enables her to be steered so as not to foul her nets.

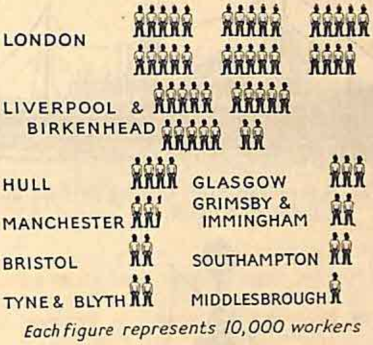


Fig. 119. Numbers of dock workers in the main British ports.

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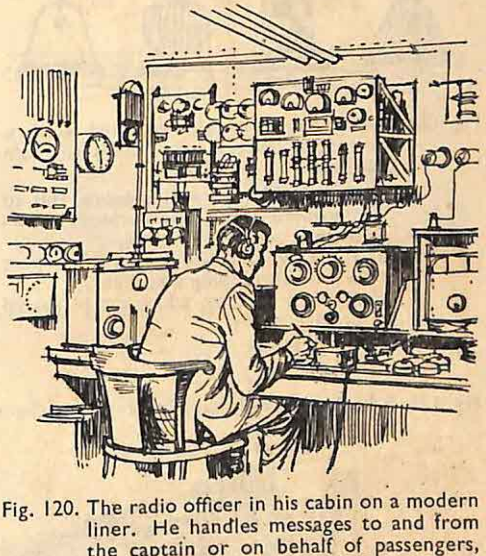


Fig. 120. The radio officer in his cabin on a modern liner. He handles messages to and from the captain or on behalf of passengers, weather reports, time signals and news (for the ship's newspaper) from land stations, and picks up calls from other ships in the neighbourhood. All these are cut out as soon as an S.O.S. call is received.

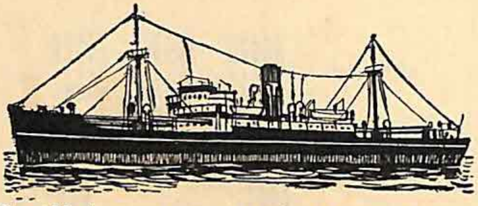


Fig. 122. A steam coaster, trading perhaps between London and Leith.

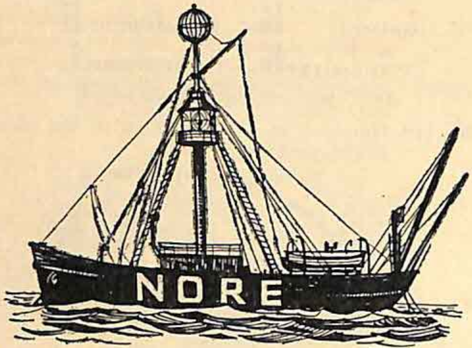


Fig. 123. A lightship is used to mark a danger area at sea.

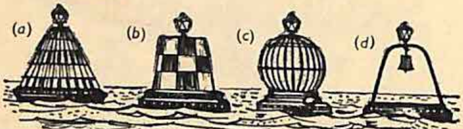


Fig. 124. Different types of buoy are used to mark submerged wrecks or indicate safe channels.

- (a) A *conical* buoy. A ship leaves this to starboard when approaching a harbour.
- (b) A *can* buoy. A ship leaves this to port when approaching a harbour.
- (c) A *spherical* buoy, which can be passed on either side.
- (d) A *bell* buoy.

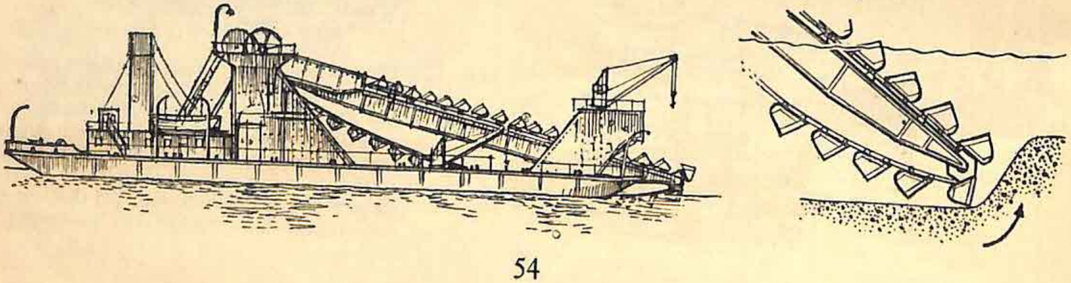
THE LITTLE SHIPS

THE little ships fall into three classes—fishing craft, coastal traders and service vessels.

The deep-sea trawlers that go out to Iceland and the other distant northern fishing grounds and the whaling factory ships that work in the Antarctic seas do not belong to the little ships, of course. But much more numerous are the North Sea trawlers that fish over the Dogger Bank, and the herring drifters that move every year around our coasts from the Hebrides to the Thames estuary. Early in the year when the herring fishery begins, the B.B.C.'s daily weather reports give special mention to the Minch area, and in the late autumn to the East Anglia area, where it finishes. Since these craft are seldom at sea for more than a day or two, the crew's quarters and fuel stores take up little space. Most of the vessel is taken up by the holds for the catch. The boats that engage in the inshore fisheries off our western shores for pilchards or mackerel are still smaller and seldom have any quarters at all.

It has been seen how, as ocean-going vessels became larger, they had to leave the smaller ports. Many of these are still visited by *coasters*. These are often ships of only a few hundred tons with but one deck and one hold. They can carry such things as coal, cement and bricks more cheaply than the railways. Many of them help to distribute foreign cargoes brought to such ports as London or Liverpool. Some of the larger craft carry a few passengers,

Fig. 125. A bucket dredger used in deepening channels or clearing them of mud, sand or gravel.



especially in the summer, *e.g.* between London and the Tyne, or Leith and the Orkney and Shetland Islands. The call of the weekly steamer causes quite a stir in the little ports along the west coast of Scotland where it is a sort of general delivery van bringing groceries and drapery, hardware and furniture, and sometimes even meat, for the local shops. In river ports such as London and Hull, scores of barges and lighters receive cargoes over the ship's side for delivery to factories and warehouses up river.

The ocean-going sailor has a warm affection for the tugs that fuss about in all big ports. When they come alongside he knows that he will soon be ashore, or, often equally welcome, be out at sea away from the turmoil of the docks. They push and pull the big ships in and out of docks or alongside wharves.

Other little ships do much for the safety of their big sisters. The pilot cutters carry the men who can guide them safely along the deep and often twisting channels. The dredgers are constantly at work deepening and straightening the harbour entrances. They haul up and carry away the mud and sand swept down by river or tide. Survey vessels watch and chart every change in position of sandbanks and fix danger buoys on wrecks and shifting sandbanks. The lightships give warning of more permanent dangers. Where ports may be closed by ice in winter, special ships called icebreakers are sometimes used to open a way for vessels trapped in port or unable to enter it. Powerful salvage vessels are ready to tow damaged craft into port for repairs or to drag stranded vessels off sandbanks.

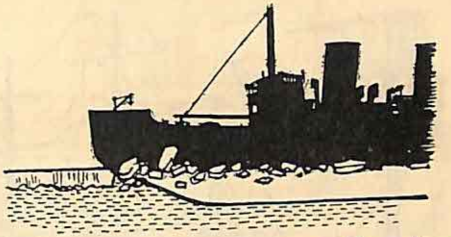


Fig. 126. An icebreaker. Its powerful engines force its sloping bows over the ice until its weight breaks the surface ice thus opening a channel. Much used in the Baltic Sea.

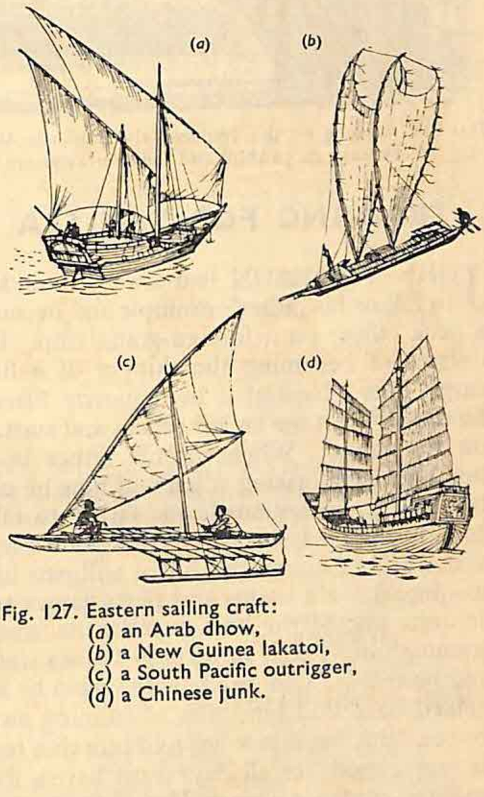


Fig. 127. Eastern sailing craft:
(*a*) an Arab dhow,
(*b*) a New Guinea lakatoi,
(*c*) a South Pacific outrigger,
(*d*) a Chinese junk.

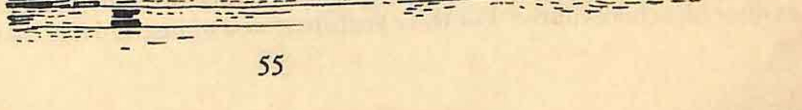


Fig. 128. Tug drawing a dumb lighter, *i.e.* one without engines.

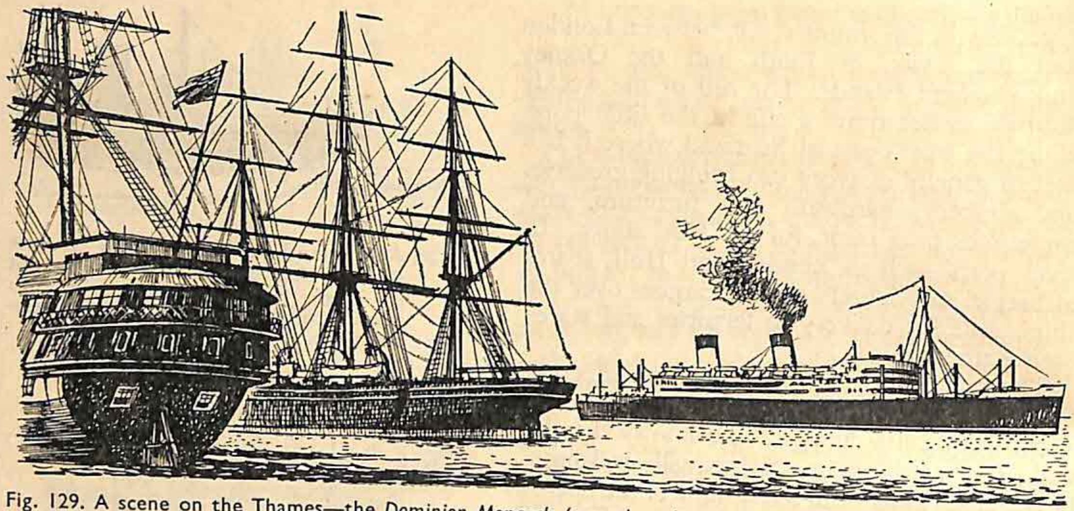


Fig. 129. A scene on the Thames—the *Dominion Monarch* (a modern liner) passes the *Cutty Sark* (nineteenth-century cargo ship) and the *Worcester* (an eighteenth-century warship later used as a training ship).

TRAINING FOR THE SEA

JOHN THOMSON had always intended to follow his father's example and become a deck officer on a foreign-going ship. He dreams of becoming the skipper of a fine cargo liner. Now that he is nearly fifteen he thinks it is time he left school and started on his career. Whenever his father is at home he keeps asking when and how he can begin. He did persuade his father to take him during his last leave to have his eyesight tested and he knows the doctor will pass him as quite fit. He swims and plays games and is quite one of the best boys in the school gymnasium so he is now ready for sea training he thinks. Old sailors with whom he has talked have told him tales of running away to sea. But his father has told him that road is now closed, for all boys must have a four month's course in a sea-training school ashore before going to sea. Besides, there are to-day so many different jobs on a ship that quite different training is needed for each branch.

A boy intending to work as a rating goes to sea after his school course. For three years he learns the ways in which ships are run and a good deal about the sea itself. He can then take a Ministry of Transport test and qualify as an A.B. (*i.e.* an able-bodied seaman). The test is mainly on things he should have learned by experience, such as to read the compass, steer a boat, cast the sounding-lead, drive a winch, launch a lifeboat, batten down a hatch and use ropes. With more experience and good work he can then hope for promotion as a petty officer, becoming perhaps a boatswain or quartermaster. If he has kept up his studies he may take the Second Mate's certificate and become a deck officer.

Since John hopes to qualify as a Master his training will be different. His father would like him to go as a cadet to a training school for officers and take their two-year course. Some of these schools are old sailing ships laid up in port and fitted out with living quarters and classrooms. There he will continue his studies of science and mathematics and learn some of the lessons the other boys learn at sea. Especially he must study navigation and all the mathematics and use of instruments that go with it. He cannot qualify as an officer by taking the Second Mate's examination until he is twenty years of age and has served at least four years in foreign-going ships. One of his years in the training school will count towards this service. John would like to go to sea at once and would like his father to arrange for him to serve under one of the bigger shipping companies who train their own officers as apprentices. In that way he would spend his whole four years at sea and be taught by the ship's officers.

In either case he will have to face the same examiners, retired officers who have had long experience of ships and the sea and know all the problems a ship's master may have to face. If he succeeds in getting his "ticket" he can then look for a job as a junior officer. As his experience grows he will have other tests to pass before he qualifies for his Master's or Extra Master's certificate. Even then he will have to work for a number of years before he can hope to secure his first command and take his "own" ship to sea.

For other types of officers there is the same round of training, experience and tests. Engineer officers must serve a four or five years' apprenticeship in an engineering works ashore and then eighteen months as watch-keeping officers at sea before they can obtain a Second Class Engineer's Certificate. Many junior engineer officers have no certificate but senior officers must have passed the tests. A further eighteen months' experience (twenty-one months if he wishes to qualify for both steam- and motor-driven ships) is called for before he takes his First Class certificate. Then he may become a Chief Engineer, but will probably serve for several years as a junior before securing that rank.

Radio officers pass tests set by the Postmaster-General, not the Ministry of Transport, and train at special schools ashore. Most of them are employed by the radio companies, but some of the larger lines employ them in the same way as other officers, promoting them as their experience grows.

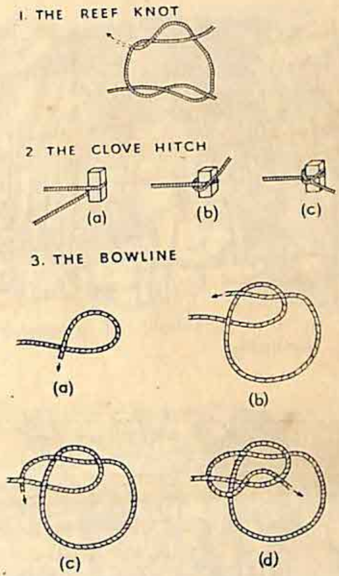


Fig. 130. Sailors' knots. Can you tie them?

Fig. 131. Apprentices learning to steer.

LIFE AT SEA

LIFE and work at sea are very different from conditions in shore jobs. This is most obvious in the matter of hours. As the voyage proceeds and the ship's longitude changes, so does the clock of course. The passenger finds that he has to change his watch nearly every day if it is to agree with the ship's clock. But that is far from being the only, or the most important, difference. Work on the ship goes on the whole clock round and for seven days a week. Working by watches, with four hours on duty and eight off, most of the deck and engine room officers and ratings put in fifty-six hours work each week. The Master and the Chief Engineer, the Purser and the Doctor, and such petty officers as the Boatswain, the Carpenter and the Cook do not "keep watch". The Quartermasters who man the helm find their work so trying that they do turns at the wheel of only two hours at a stretch.

Except in heavy weather or when things go wrong, daily life at sea follows a regular routine. With fine weather and good visibility the officer on the bridge has little to do and the engine room staff need only see to the oiling. Feeding and cleaning fires in the stokehold go on smoothly. Deck ratings on watch work under the Boatswain's direction, keeping everything shipshape. Boats and their gear are regularly overhauled and checked frequently, decks washed down and metalwork cleaned or repainted. The Boatswain (always called the bo'sun) is the chief petty officer and receives his orders from the Chief Officer or Mate, the second in command, and sees that they are carried out satisfactorily. The Master will be sure to spot anything neglected or badly done when he makes his morning inspection.

The life of the sailor is now much pleasanter than it used to be. Discipline is strict—it must be if dangers are to be met promptly and safely overcome—but it is no longer harsh and brutal. Living conditions have been greatly improved. Instead of the open crowded forecastle, with a

Fig. 132. In the stokehold of a coal-burning steamship.

Fig. 133. Old type crew's quarters in the forecastle.

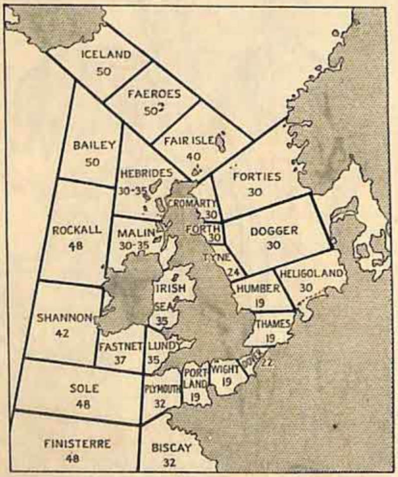


Fig. 134. Areas referred to in British weather reports. The figures give the average number of gales per year in each area.

narrow table and rough benches taking up most of the room between the bunks, the modern ship houses its crew in two-berth cabins. Decent washrooms with hot water are provided. Meals are now brought from the ship's galley (the cookhouse) by a boy and served in a messroom. In the bigger ships there is also a recreation room where games can be played or books from the ship's library read in peace. The older ships are not so well fitted, of course, and conditions are still bad in some, but in all the newer ships the comfort of the men is well provided for.

On ships with fewer than 100 men on board the Master must act as doctor and a man's mates are his only nurses. In serious cases advice may be got by radio from a bigger ship.

Two hundred years ago men were often forcibly taken on board ship to serve as sailors. Men who had just returned from long voyages were kidnapped and drunken men *shanghai-ed* in order to bring crews up to strength. To-day all crews are volunteers and their engagement and payment are closely overlooked. Pay was as bad in the old days as food and accommodation. Only during recent years have wages been raised to decent levels. During the Second World War, however, the dangers of life at sea, even in peace-time, became so obvious that changes were made. The National Maritime Board, which settles conditions and pay in the Merchant Service, introduced in 1947 new rules and rates of pay. An A.B. now earns £24 a month. For each year of good service, up to four years, he receives an extra pound a month. For sailing days and arrival days, when he must often work more than his usual eight hours, he is allowed overtime pay. In each year he is entitled to fourteen days' leave with pay. He works on Sundays, of course, and has no half-days off on Saturdays. As part return for this he has an extra half-day's leave for each Sunday spent at sea. It has also to be remembered, of course, that he receives his food and quarters free.

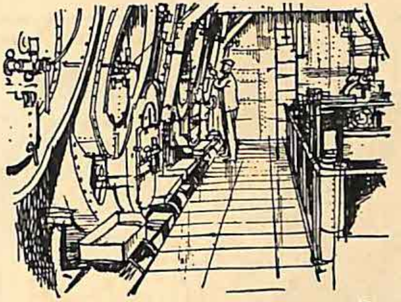


Fig. 135. Stokehold of an oil burner. Compare with Fig. 132.

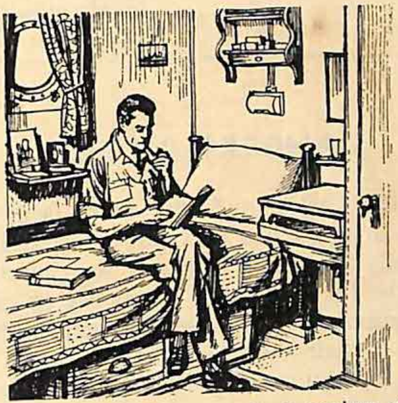


Fig. 136. Quarters for crew in a modern ship. Compare with Fig. 133.

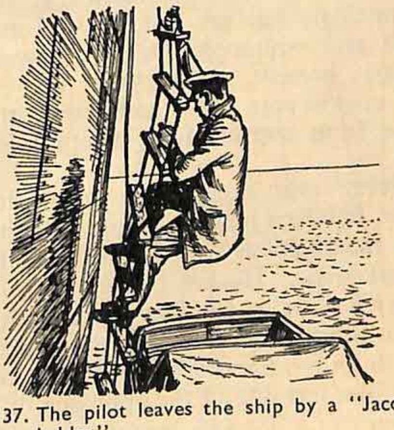


Fig. 137. The pilot leaves the ship by a "Jacob's ladder".

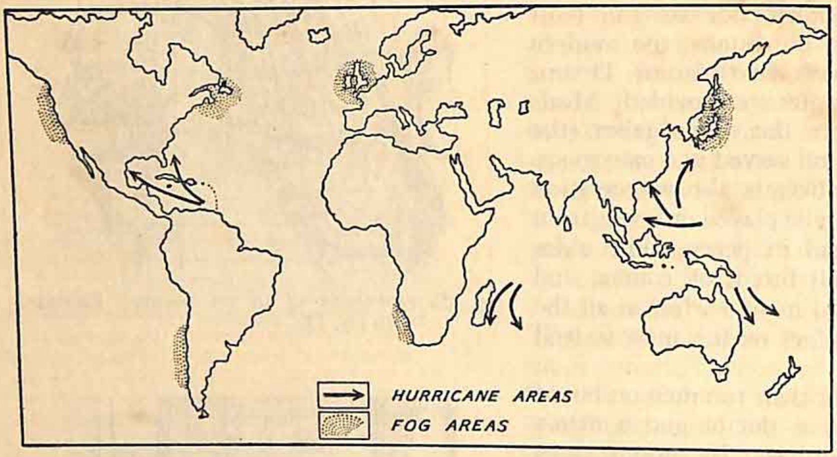


Fig. 138. Danger areas where dense fogs and severe windstorms are most frequent.

DANGERS AT SEA

THE sailor and his ship face many dangers when they put to sea and must usually face them alone. They cannot ring up the fire brigade or the police or call for an ambulance. Nor can they get immediate help if their ship is damaged or get a spare part by return of post. In the early days when ships were small and voyages short the captain could take his vessel into the nearest harbour for shelter. Modern vessels now face the worst of storms at sea and surprisingly few are lost, so well are they built and equipped. Danger, however, is always present, throughout the voyage and even in port. The most serious troubles arise from storms, fogs, floating ice and fire.

Every storm brings some risk to ship and crew, but even howling winds, blinding rain and mountainous seas do not scare the seasoned sailor. He has become used to the angry fury and knows how to deal with it. His radio and the signs given by wind and cloud, which he has learned by experience to read, give him warning of the approach of a gale. When this is forecast everything on deck is made fast, holds are battened down and portholes closed and secured. Then calmly he waits and lets his ship "ride the storm". Strange as it may seem to the landsman the sailor is happiest at such times if he is far away from shore. He likes to have plenty of "sea room". All but the very worst weather can be ignored by well-found modern ships. West Indian hurricanes and typhoons of the China Sea are still dreaded and avoided if possible.

Of all the perils of the sea probably fog is most disliked by the sailor, for the simple reason that it hides from him any approaching danger and therefore prevents him from taking steps to avoid it. Half the collisions of ships at sea are due to fog and so are many of the cases in which ships run ashore. For most of the bigger and better equipped ships, however, fog is to-day rather a cause of delay than of danger. Unfortunately those parts of the ocean where thick fogs are common are also those which are busy with shipping. These include such places as the English Channel, the seas off Newfoundland and those near Japan. To prevent mishaps through fog, ships now travel along regular routes or "shipping lanes" just as land traffic keeps to its own side of the road. Modern science has provided radar equipment, now fitted on most liners, so that they can see things quite a long way ahead of them in the thickest fog. Thus the *United States* in making her record eastward run made 34 knots all through a Newfoundland fog.

In the northern seas ice is a frequent danger, especially in summer when the ice breaks up and drifts southwards in the surface currents. Icebergs, which break off from the Greenland glaciers, are carried by ocean currents right across the North Atlantic shipping routes. In the spring of 1912 the large new liner *Titanic* struck an iceberg on her maiden voyage and sank with the loss of 1513 lives. One result of this terrible mishap was the setting up of the Iceberg Patrol. Its vessels look out for icebergs and try to destroy them or at least warn ships of their whereabouts.

Fire at sea is a serious danger. Some cargoes, such as coal, grain and copra, may grow hot and ignite of themselves. Such fires are difficult to put out, though there is no lack of water which can be pumped on them. Careful loading, plenty of ventilation in the holds and a watch for any unusual heating are the best ways to prevent such fires.

Though the unsinkable ship has still to be built, ship designers have gone a long way towards achieving this. The hull of each ship is now divided into separate rooms or compartments by means of bulkheads, and it is usual to fit each vessel with a double bottom. Thus a ship may remain afloat even if her hull has been pierced by a collision or by running aground. Even when a ship has broken in half the two portions have remained afloat and been brought to port.

On board ship the Master has all the powers of a magistrate or a police officer. He can order the arrest and imprisonment of any of the crew or passengers who attack others or endanger the ship or its cargo in any way.

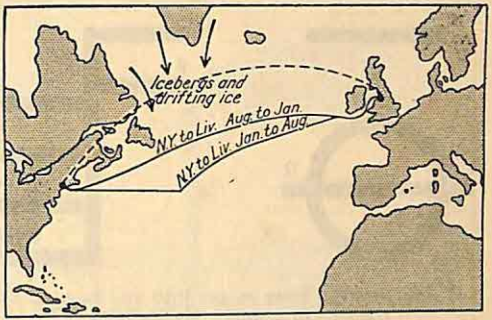

Icebergs and drifting ice
N.Y. to Liv. Aug. to Jan.
N.Y. to Liv. Jan. to Aug.

Fig. 139. North Atlantic routes. The broken line shows the shortest route for an aeroplane from Liverpool to New York. Why do both ship routes steer south of Newfoundland? The southern line is followed in the iceberg season.

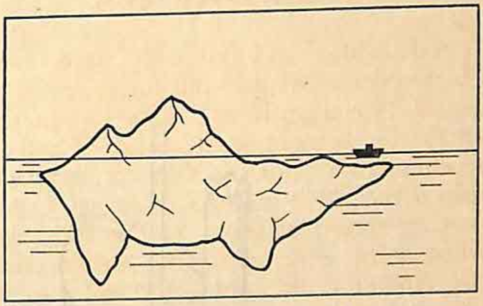


Fig. 140. The submerged portion of an iceberg is much larger and spreads far wider than the exposed portion.

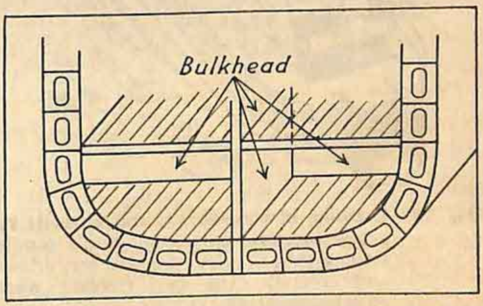


Fig. 141. Bulkheads and a chambered double hull make for safety at sea.

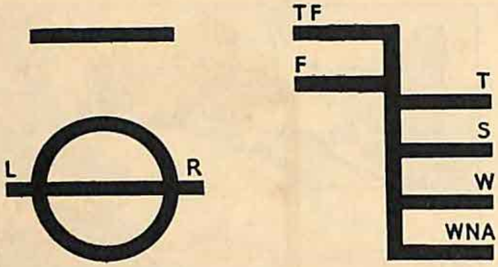


Fig. 142. Plimsoll lines as cut into and painted on the hull of a ship. The Ministry of Transport lays down the regulations fixing these lines on British ships.
As the ship is loaded, its hull sinks in the water. The lines on the right show the limits of loading for voyages under different conditions.
The gross tonnage of the ship is a measure of the volume of the hull below the line LR; every 100 cubic feet is one gross ton.

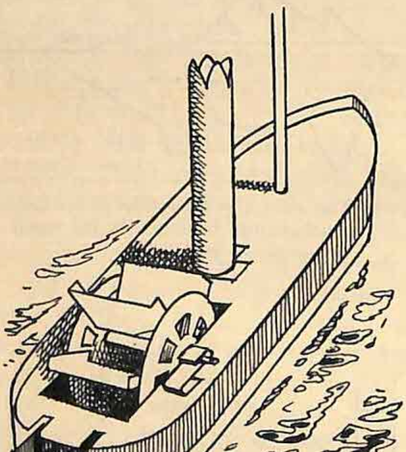


Fig. 143. Drawing of a cardboard model made by a boy to show how Symington's paddle steamer, the *Charlotte Dundas*, was driven and steered. The two rudders were coupled together.

1 Fig. 142 shows what are known as the Plimsoll load lines. They are cut and painted on the hull of a merchant ship to show the safe depth to which she may be loaded. L R is the Lloyd's Register mark used in calculating her capacity. The other letters indicate load levels according to the voyages to be undertaken, thus:

TF is for voyages in tropical freshwater, F in other freshwater; T for tropical seas, S and W for winter and summer sea voyages outside the tropics, and WNA for winter voyages in the North Atlantic.

With the same load, will a ship float higher or lower in the water in a river or in the sea? Why?

Why do the winter and summer lines differ and why is the Winter North Atlantic line lowest?

(Samuel Plimsoll was a Plymouth M.P. who introduced into Parliament the first law to prevent in this way the dangerous overloading of ships.)

2 Fig. 143 is a diagram of Symington's steamboat built in 1802, the first to be successfully driven by a steam engine. (See page 14.) Make a model from the drawing and explain how the ship worked.

3 How is a ship steered? Draw diagrams to show how the rudder acts on the water to change the direction of movement of the ship.

4 Here are the figures referring to three ships of different classes:

Luxury Liner (*Queen Mary*), 81,000 tons, speed $28\frac{1}{2}$ knots; engines 158,000 h.p.
Passenger-Cargo Liner (*Orcades*), 28,000 tons, speed 22 knots; engines 42,500 h.p.
Cargo Liner, 20,000 tons, speed 16 knots; engines 12,000 h.p.

Why are there such great differences in the horse-power of the engines in the three classes?

5 Of the 21,000 deck officers on British ships in 1952 roughly 14,000 were certificated, 2,000 uncertificated and 5,000 cadets or apprentices. Of the 24,000 engine room officers 7,500 were certificated and 16,500 uncertificated.

Why do the numbers differ so much between the two classes?

6 What are the chief Canadian ports?

The total weight of cargoes (in hundred thousand tons) shipped from them each month in a recent year were:

Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
15	6	6	5	6	8
May	**June**	**July**	**Aug.**	**Sept.**	**Oct.**
10	10	10	10	10	12

Why were cargoes so low during the five months December to April and highest in October and November? What ports did most of the exporting between November and May?

7 Fig. 144 is a drawing of the first iron steamship. It was built in 1821 on a Staffordshire canal, carried in sections to London and put together again there. It carried a cargo to France and then traded for some years between Paris and Havre on the River Seine.

Why do you think it was built in Staffordshire?

In what ways does it differ from a modern steamship in design?

8 Ports may be grouped into three main classes: (*a*) Commercial ports dealing with goods traffic; (*b*) packet stations dealing with passenger and mail traffic; (*c*) fishing ports concerned mainly with the landing of fish.

Draw up lists of the more important ports of each type in the United Kingdom.

9 Steel bulkheads (Fig. 141) are of great value in lessening the danger to a ship from (*a*) collision, (*b*) fire. Explain how in each case.

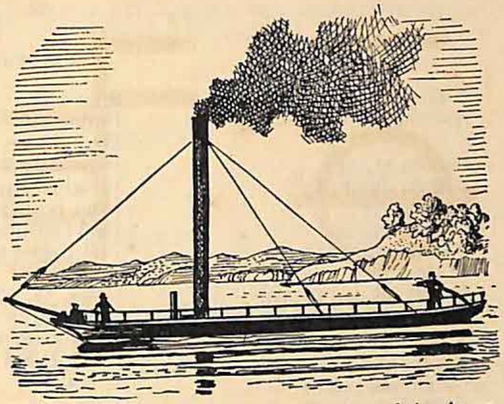


Fig. 144. Copied from an old drawing of the *Aaron Manby* steaming on the Seine. This ship was named after the owner of the iron-works where it was built. It worked on French rivers for 20 years and was finally broken up one hundred years ago. It proved that ships could be built of iron.

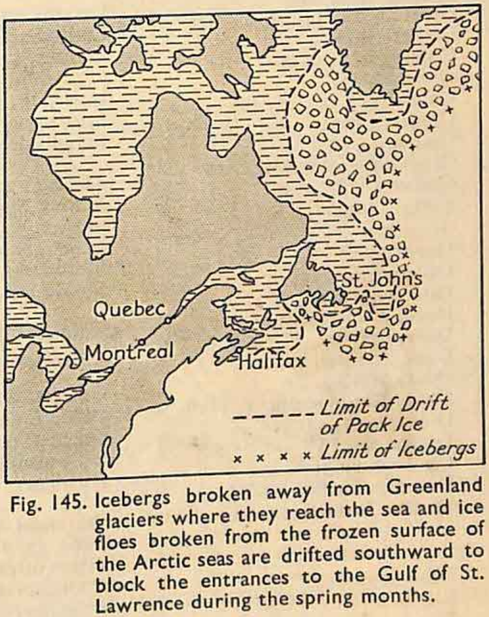
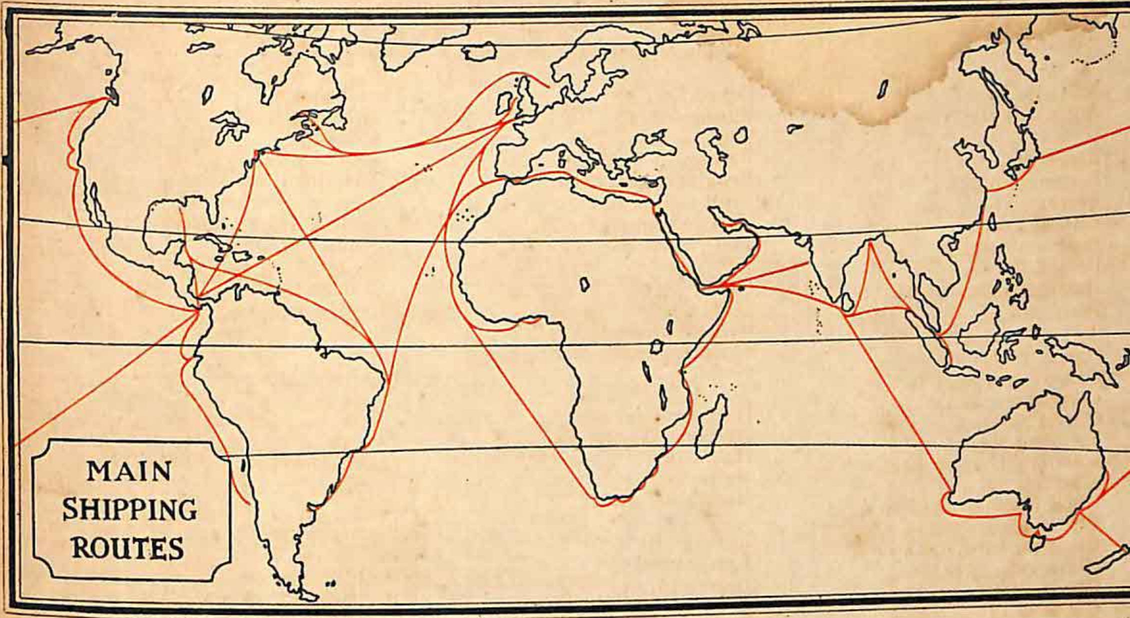
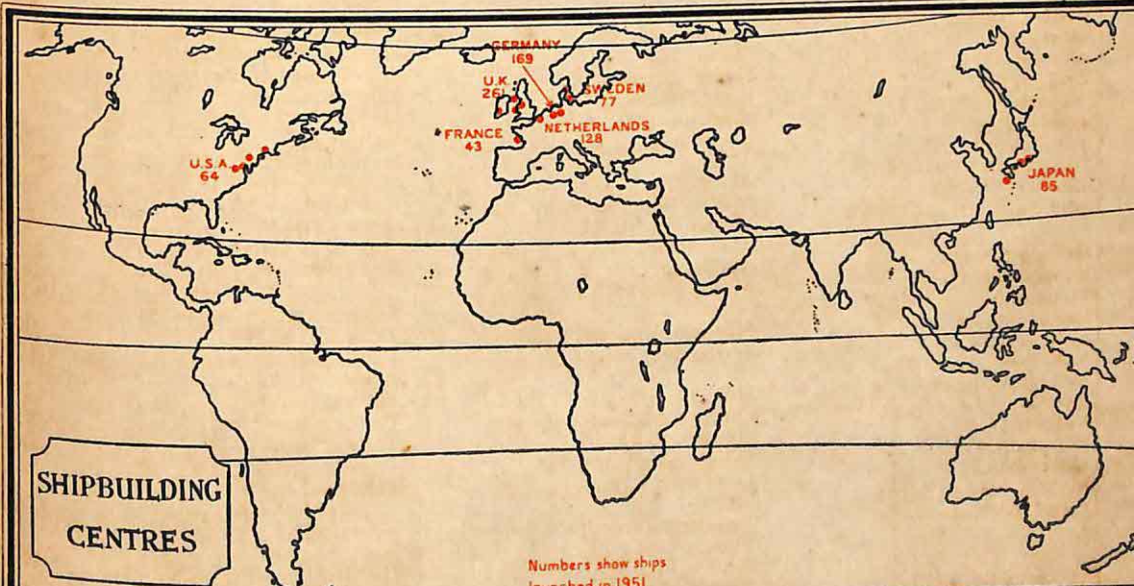

St. John's
Quebec
Montreal
Halifax
– – – – – Limit of Drift of Pack Ice
× × × × Limit of Icebergs

Fig. 145. Icebergs broken away from Greenland glaciers where they reach the sea and ice floes broken from the frozen surface of the Arctic seas are drifted southward to block the entrances to the Gulf of St. Lawrence during the spring months.


MAIN
SHIPPING
ROUTES


SHIPBUILDING
CENTRES
GERMANY
169
U.K.
261
SWEDEN
77
NETHERLANDS
128
FRANCE
43
U.S.A.
64
JAPAN
85
Numbers show ships
launched in 1951.

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MEN AT WORK